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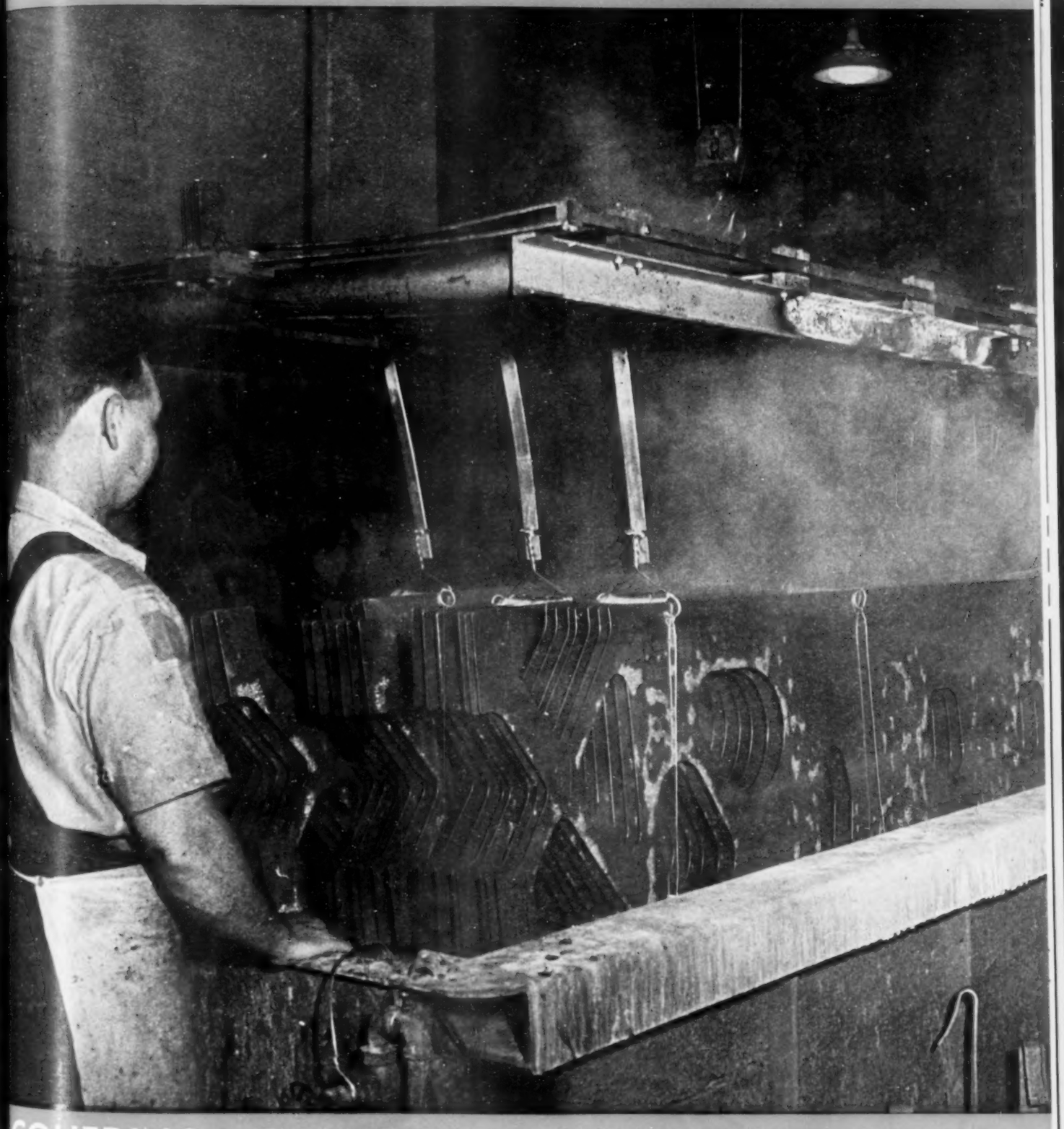

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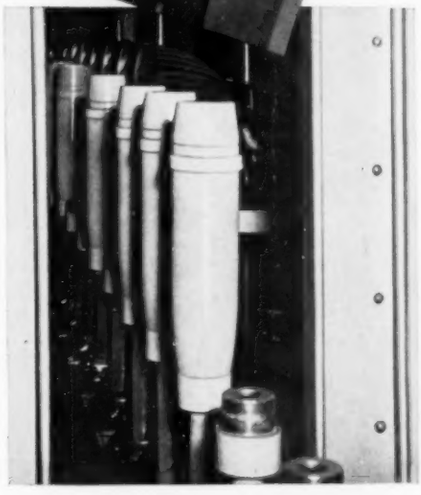

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MAINTENANCE

In attempting to fulfill the demands of the times for greater and greater production, the finishing industry—and for that matter, all industries—are finding still another problem with which to contend. It is the problem of maintaining equipment which is being operated two and even three shifts per day. Experience has shown that as the number of hours which a machine operates is increased there is a more than proportional increase in wear and deterioration.

There is no royal road to maintenance under such conditions. Constant attention must be paid to a hundred details. Lubrication of moving parts must be regular and thorough. Equipment must be kept clean. Operating procedures must follow exactly the recommendations of the engineering department or the manufacturer of the equipment.

In the case of finishing it is particularly important to keep a close eye on the maintenance of equipment operating for long hours. So many pieces of equipment are necessary to produce a finish. Compressors, spray guns, ovens, sanding machines, conveyors, agitating tanks are a few. If any one of these individual pieces of equipment fails due to neglected maintenance, it may very easily halt—or at least slow down—the entire finishing line. It pays, therefore, to watch each piece of equipment closely. In addition to the work of the regular maintenance crew, it may be wise to advise the individual operators of the importance of their particular machine and ask for their cooperation in reporting any evidences of possible breakdown.

Maintenance is a costly overhead item as everyone knows. However it is common sense that it is better to pay to keep equipment running and production going than to pay for its repair after it has stopped operating and production has ceased.

L. H. LANGDON, *Publisher* • T. A. TRUMBOUR, *Business Manager* • DR. WALTER R. MEYER, *Editor*

PAINTING MAGNESIUM ALLOYS†

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The increasing use of magnesium alloys in numerous industrial fields, especially the aircraft industry, has focused attention on this ultralight metal. For most of these applications there is need for serviceable protective coatings. In order to evaluate different protective coatings, a special accelerated test was used which comprised cycles of alternate immersion in synthetic sea water, combined with outdoor weathering at an angle of 45° to the vertical facing south.

By proper selection of alloys, surface treatment, and painting system, it has been found possible to obtain satisfactory protection on magnesium alloys for several years, even under relatively severe service conditions.

MAGNESIUM and its alloys are finding increased use in industry because two decades of research and development have supplied satisfactory alloys and practical fabricating techniques. In meeting the requirements of many fields of application, protective coatings are necessary if magnesium alloys are to give the best service of which they are capable. The special characteristics of this metal have made painting a problem which has required long and tedious investigation to reach a practical solution. Winston and his associates[6, 9], Whitmore[8], and more recently the Golden Gate Production Club[5] of the Federation of Paint and Varnish Production Clubs have contributed to the solution of this problem.

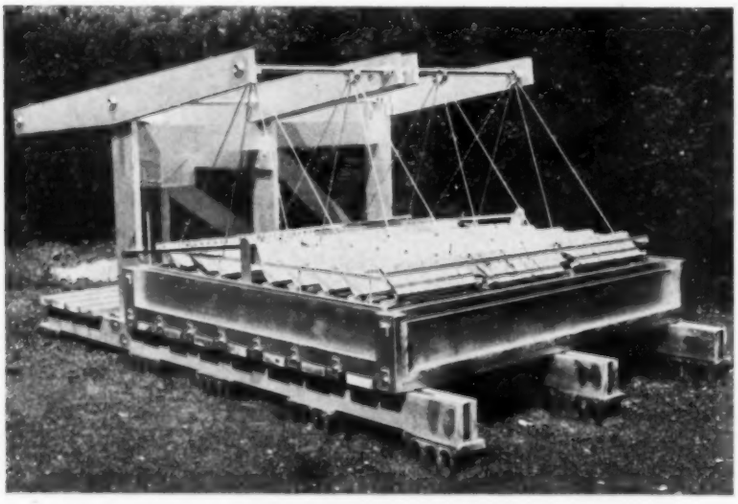

FIGURE 1. ALTERNATE IMMERSION EQUIPMENT FOR ACCELERATED TESTING OF PAINT FINISHES

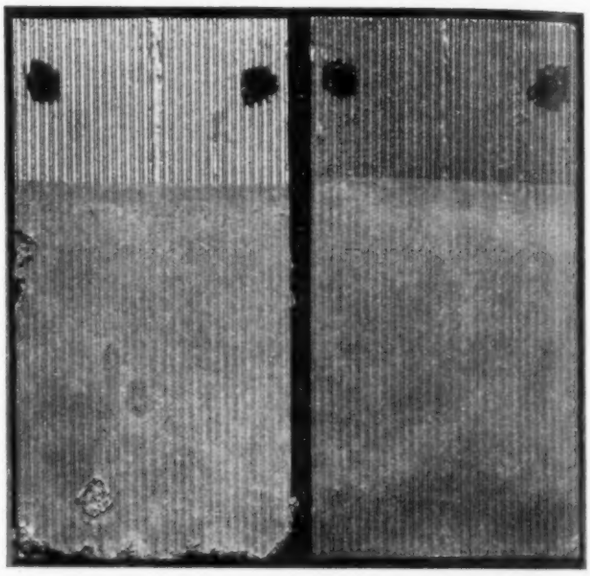

FIGURE 2. EFFECT OF ALLOY COMPOSITION ON PAINT PERFORMANCE AFTER 9 DAYS IN THE ALTERNATE IMMERSION TANK

Left, alloy AM240; *right*, alloy AM265

For the past ten years and more, Aluminum Research Laboratories have been engaged in the development of protective coatings for magnesium and its alloys. Protective coatings can be produced by chemical or electrochemical treatment of the surface of the metal as well as by the application of paint coatings. The greatest protection is obtained by a combination of both methods.

In investigations of this character, accelerated exposure tests are essential if rapid progress is to be made in evaluating coatings. To be significant, however, the test should give reliable information as to the relative performance of different coatings in service. The salt spray test has been used to some extent, but this test ignores the effect of sunlight on the coatings and other important factors.

Accelerated Exposure Equipment

An accelerated test which we have found effective for evaluating coatings on aluminum[4] has, with some modification, also proved useful for testing coatings on magnesium and other metals. Figure 1 is a photograph of the equipment, located outdoors at the rear of the

† Reprinted from **Industrial & Engineering Chemistry 33,** 932 (1941).

laboratories in New Kensington. It comprises a large wood tank 7 × 7 feet and 12 inches deep, which is filled with water containing 3.5 per cent sea salt, the average concentration found in sea water. From one end of a movable beam, supported in the center, is suspended a metal framework on which are mounted the various coated panels to be tested. The panels are mounted at an angle of 45° to the vertical facing south, as is customary in outdoor exposure tests of paints. The other end of the movable beam is attached by a connecting rod to a train of gears operated by a small motor. The beam is carefully counterbalanced so that it can be easily moved to lower or raise the metal framework and thus hold the panels in and out of the water. The small motor is connected in circuit with an electric timing device which can be set to raise and lower the panels automatically in any desired cycle. This apparatus, in effect, brings tidewater paint testing to our own back yard.

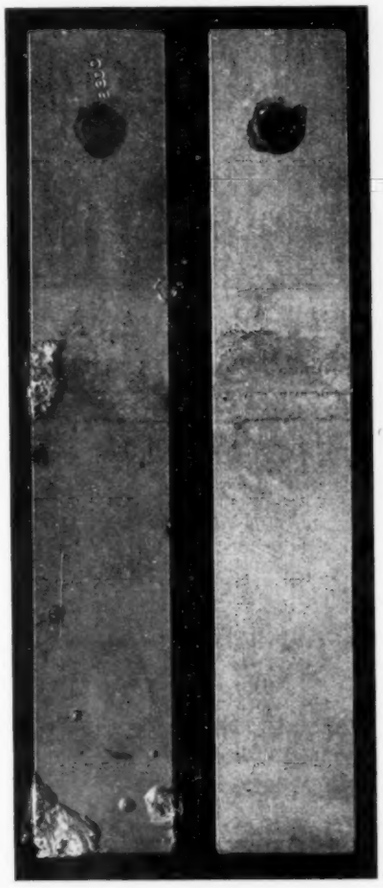

FIGURE 3. EFFECT OF ALLOY COMPOSITION ON PAINT PERFORMANCE AFTER 4 WEEKS IN THE ALTERNATE IMMERSION TANK

Left, alloy AM57S; *right*, alloy AMC57S

Various cycles of tests were tried, but the one finally adopted comprised two 5-minute immersion periods per hour, each followed by a 25-minute drying period. This length of time for drying has proved ample in all tests conducted so far. Thus forty-eight cycles per day can be obtained instead of only two as in tidewater testing. Under these conditions it has been possible to show differences between some coatings within a few weeks, although a much longer time is required with the better coatings and on the magnesium alloys more resistant to corrosion. In some cases, signs of failure appear within a week whereas it takes a year of seacoast atmospheric exposure to produce the same degree of failure; this indicates the severity of the test. As might be expected, it has been found that weathering goes on more rapidly in the summer under the action of warm salt water and the summer sun. During the winter months the equipment is not operated because of ice formation on the panels and even in the tank itself.

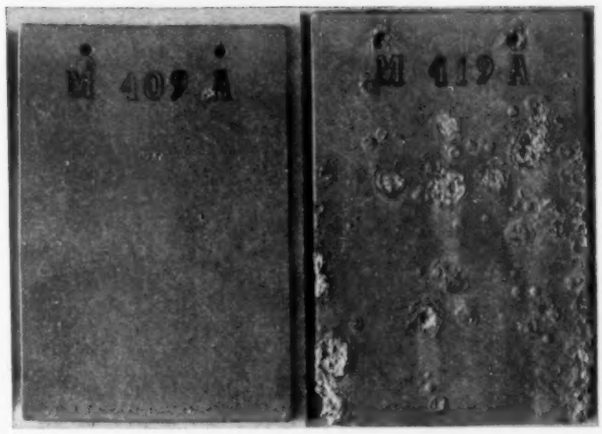

FIGURE 4. EFFECT OF SURFACE TREATMENT ON PAINT PERFORMANCE

Satisfactory treatment on left panel, poor treatment on right panel of AM265 casting alloy.

Effect of Alloy Composition

Casting alloys of the American Magnesium Corporation were used, which have the following nominal composition, in addition to magnesium itself:

Alloy	% Al	% Zn	% Mn
AM265	6	3	0.2
AM240	10	—	0.1
AM57S	6.5	0.7	0.2
AMC57S[a]	6.8	1.2	0.2

[a] With maximum iron and nickel content of 0.005% each.

A rather wide difference has been found in the ability of paint to protect the various alloys. This is well illustrated by the photograph of two typical casting alloys shown in Figure 2. The same surface treatment and paint coatings were applied to the two panels. After 9 days in the test the panel of AM265 showed practically no failure whereas considerable failure of the coating was observed on the AM240 panel. A similar AM240 alloy panel, without a paint coating but having the same surface treatment, was covered with a continuous film of corrosion product after 2 days in the accelerated test. Without the surface treatment, metal corrosion would have occurred within 24 hours. Some corrosion appeared on the unpainted surface of an AM265 alloy panel after 2-day exposure, but to a minor extent. The difference is largely one of alloy composition[2].

A further demonstration of the fact that paint appears to give the best protection on the most resistant alloys is shown by Figure 3. These panels were given the same surface treatment and paint coatings, but the alloy of the panel on the right was much superior in its resistance to attack by salt water even without added protection. This picture was taken after 4 weeks in the alternate immersion tank, at which time the test of the AM57S panel on the left was discontinued. The AMC57S panel was in good condition after more than 66 weeks in the test.

Preparation of Magnesium Alloy Surfaces for Painting

In common with other metals, adequate preparation of the surface of magnesium alloys is vital to good paint performance. It is especially important in the case of magnesium alloys which are to be subjected to severe conditions in service, such as contact with salt-laden air at the seacoast where seaplanes must exist.

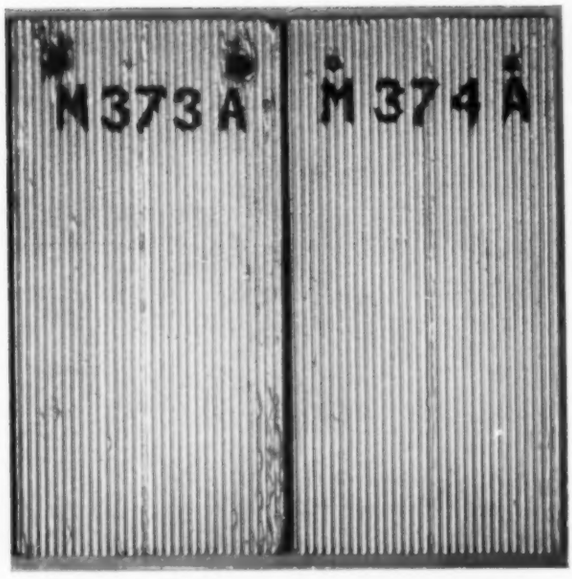

FIGURE 5. EFFECT OF PIGMENTATION OF PRIMER

AM265 panel on left primed with iron oxide-zinc chromate paint, panel on right with paint pigmented with zinc chromate alone.

As in the case of aluminum, films and coatings can be formed on magnesium and its alloys by a variety of chemical or electrochemical treatments[1, 3, 7]. Magnesium oxide or hydroxide is not so insoluble in water or so impervious as the oxide on aluminum, and hence is not so protective. However, the best of the coating methods now available offer substantial protection to magnesium and its alloys and are indispensable as surface preparation for the subsequent application of paint.

Probably the best known and most widely used of these methods is commercially termed "chrome pickle", and is applied by immersing the article to be coated in a strong solution of nitric acid and sodium dichromate at room temperature or warmed somewhat[1]. The treatment period varies from about 30 seconds to 2 minutes, depending upon the age of the solution. The article is then removed, rinsed in cold water, followed by immersion in hot water, drained, and dried. Most castings, extrusions, and other articles are given the chrome pickle treatment by the manufacturer, even if they are not scheduled for painting.

One of the best protective methods is a two-step process in which the article, after the chrome pickle treatment, is sealed by immersion in a boiling solution of sodium dichromate for 30 minutes (Figure 4).

Another effective treatment is the HF-dichromate method described by Schmidt, Gross, and deLong[7]. This is also a two-step process consisting of 5-minute immersion in 15 to 20 per cent hydrofluoric acid at room temperature followed by thorough rinsing in running water. The second step consists of boiling for at least 45 minutes in a 10 per cent solution of sodium or potassium dichromate, followed by rinsing in cold and hot water. These authors have very effectively summarized the available methods of treating magnesium alloy surfaces prior to painting.

Cleaning of a magnesium article prior to the coating and painting steps is an important element in securing proper protection. Foreign matter or impurities on the surface may be removed by immersion in an acid solution; the chrome pickle solution, which is frequently applied by the fabricator as a routine treatment, may serve this purpose. Grease and oil can be removed with a hot alkaline cleaner, such as one containing trisodium phosphate and sodium carbonate. More detailed information on cleaning procedures is given in the literature[1, 7].

In our investigations a variety of coatings was investigated as bases for paint. Figure 4 shows two AM265 magnesium alloy castings; the surfaces were given different types of chemical treatment and then painted in the same manner. These panels had been exposed in the alternate immersion equipment for 6 weeks. Panel M409A received the chrome pickle followed by a sealing treatment in dichromate solution and panel M419A received another chemical dip coating which proved inadequate. This illustrates the importance of selecting the proper type of surface treatment where the painted article is to be subjected to severe service conditions. Practically no failure had occurred on panel M409A, whereas the surface of panel M419A shows rather serious corrosion failure resulting from inadequate protection.

Selection of Priming Coat

The chief requisite for a priming coat of paint, for use on magnesium alloys not subjected to severe service conditions, is good adhesion. For many applications, however, the primer must also have satisfactory corrosion-inhibitive properties as well as good resistance to moisture penetration. It is therefore a safe policy to consider all of these qualifications in selecting the priming coat for magnesium alloys.

In the primer, both the pigment and the vehicle play an important part. Of the pigments tested, zinc chromate alone shows good corrosion-inhibiting properties on magnesium alloys. To be most effective, the zinc chromate

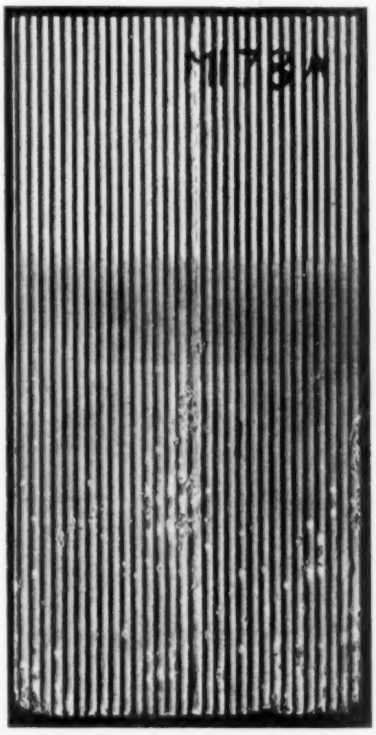

FIGURE 6. PANEL OF AM240 CASTING ALLOY WITH THREE (*top*) AND TWO (*bottom*) FINISH COATS OVER THE PRIMER

FIGURE 7. AM265 PANELS FINISHED WITH ALUMINUM PAINT (*left*) AND LIGHT GRAY ENAMEL (*right*) OVER ZINC CHROMATE PRIMER

should constitute all or essentially all of the pigment content of the primer. Primers pigmented with a mixture of iron oxide and zinc chromate have given definitely poorer protection. Figure 5 shows two AM265 magnesium alloy panels which had been exposed for one week in the alternate immersion test. Each panel received a chrome pickle treatment prior to painting. Panel M373A primed with an iron oxide-zinc chromate primer followed by finishing coats of aluminum paint, had already begun to show signs of failure by blistering of the paint and corrosion of the metal surface. Panel M374A shows practically no failure; it was primed with a paint containing zinc chromate as pigment and given the same finishing coats as M373A. These results have been confirmed by numerous similar tests.

To obtain a paint highly impervious to moisture, the vehicle must be carefully chosen with this objective. At the same time the vehicle must show good adhesion to the metal. Certain of the synthetic resin varnishes have demonstrated their ability to exclude moisture to a high degree and at the same time show good adhesion to magnesium alloys. The well-known P27b zinc chromate type of primer contains such a vehicle. This type of primer has given good protection on magnesium alloys. For surfaces which are to be in contact with salt water, varnishes of moderate oil length made with 100 per cent phenolic resins are especially suitable and give excellent results. For example, panel M377A (Figure 9) was primed with a zinc chromate primer made with a 100 per cent phenolic resin varnish of approximately 20-gallon oil length, containing about one part of linseed oil and three parts of tung oil.

Finishing Coats of Paint

The number of finishing coats of paint to be applied over the primer for protecting magnesium base alloys will vary with the type of service. However, for adequate protection under severe conditions of use, three finishing coats are needed; in other words, a four-coat system should be employed. This is demonstrated by the panel in Figure 6. This AM240 magnesium alloy casting was given a chrome pickle surface treatment and primed with a P27b zinc chromate type primer. The top half was then given three coats of aluminum paint made with a 33-gallon phenolic resin varnish whereas the lower half received but two finishing coats of the same aluminum paint. The value of the extra finishing coat is clearly apparent, as no failure is noted on the upper part of the panel after 2 weeks in the alternate immersion tank. Similar tests at seacoast locations indicated one to two years longer life with the extra coat of paint.

One of the most important properties of the finishing paint is high resistance to moisture penetration. This property is determined by both the pigment and the vehicle used. Tests show that aluminum paint can be made with higher moisture impedance than almost any other paint. In the tests of magnesium alloy panels in the alternate immersion tank as well as at a seacoast location in air exposure, aluminum paint has consistently been more protective than top coats containing any other pigment. Panel M378A (Figure 7) was given three coats of aluminum paint over a zinc chromate primer, whereas panel M387A received three finishing coats of a gray pigment paint over a zinc chromate primer. The scratches were made in these cast magnesium alloy panels after 5-week exposure to determine the adherence and protecting qualities of the coating over a damaged area. Very little failure occurred on panel M378A, even in this scratch, after 26 weeks in the alternate immersion tank.

Similar behavior was observed with these two types of finishing paints exposed on seacoast land racks. The cast AM240 panels in Figure 8 had been exposed for 31 months at Point Judith, R. I., within 100 yards of the seashore. Panel M95J on the left received two and three finishing coats of aluminum paint and panel M96J received two and three finishing coats of gray-tinted enamel made with titanium dioxide in the same long-oil phenolic resin vehicle used for the aluminum paint. Both panels received the same surface treatment and the same zinc chromate primer made with a 33-gallon phenolic resin varnish. Panel M95J shows considerably less failure than panel M96J. The value of the additional finishing coats on the upper halves of the panels is also clearly apparent.

The choice of vehicle for the finishing coat is also im-

FIGURE 8. AM240 PANELS FINISHED WITH THREE (*top*) AND TWO (*bottom*) COATS OF ALUMINUM PAINT (*left*) AND LIGHT GRAY ENAMEL (*right*) OVER ZINC CHROMATE PRIMER

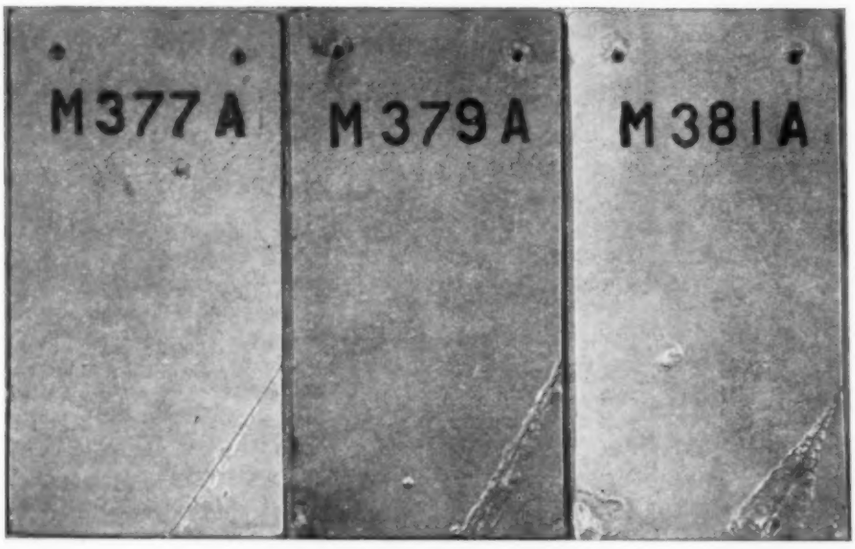

FIGURE 9 (*Left*). EFFECT OF VEHICLE FORMULATION OF PAINT ON PROTECTION AFFORDED

portant, as previously stated. In the alternate immersion tests, as well as in tests on the seacoast land rack at Point Judith, phenolic resin varnishes give the best service. The shorter oil varnishes appear to protect better than those somewhat longer in oil. This is illustrated by two of the panels shown in Figure 9. Panels M379A and M381A, both of alloy AM265, were given the same surface treatment and one coat of a P27b-type primer. To panel M379A were applied three coats of aluminum paint made with 2 pounds of Standard aluminum paste per gallon of an approximately 20-gallon phenolic resin varnish; M381A received three coats of aluminum paint made with the same ratio of aluminum pigment in a 33-gallon phenolic resin varnish. The panels were scratched down to the metal after 5-week exposure; after 20 weeks, when the photograph was taken, less failure of the coating was observed on panel M379A finished with the 20-gallon vehicle than on panel M381A.

Panel M377A was of the same alloy and had the same surface treatment as the other two. However, M377A was primed with a zinc chromate primer made with the 20-gallon phenolic resin varnish described above and received three finishing coats of aluminum paint made with the same vehicle. This panel showed very little failure after 20-week exposure and thus demonstrated the value of an integral system based on a vehicle of unusual properties for this type of service. This 20-gallon 100 per cent phenolic vehicle containing about one part of linseed oil and three parts of tung oil has proved outstanding in the tests in the alternate immersion tank.

A final comparison of three complete painting systems is shown in Figure 10. These panels are of alloy AM265 which possesses good resistance to corrosion. All of the panels received the chrome pickle prior to painting. M402A was primed with a zinc chromate primer made with a 20-gallon 100 per cent phenolic resin varnish containing about one fourth linseed oil and three fourths tung oil. Three finishing coats of aluminum paint, made with 2 pounds of Standard aluminum paste per gallon of the same vehicle used in the primer, were applied. After 8 weeks in the alternate immersion test no failure could be found on this panel. Panel M406A (center) was primed with a zinc chromate primer made with a 25-gallon 100 per cent phenolic resin varnish containing equal parts of linseed and tung oils; it received three finishing coats of aluminum made with the same vehicle as used in the primer. Only one small corrosion pit had appeared in this panel after 8-week exposure. This system was therefore only slightly less effective than the one on panel M402A. The panel on the right, M408A, was primed with a P27b-type zinc chromate primer followed by three coats of aluminum paint made with a 33-gallon 100 per cent phenolic resin varnish containing only tung oil. After 8-week exposure several spots of severe corrosion had occurred, although general failure of the coating was not evident. However, this painting system was definitely inferior to the systems

FIGURE 10 (*Left*). PANELS OF AM265 ALLOY FINISHED WITH ALUMINUM PAINT MADE WITH VEHICLES OF VARYING OIL LENGTH

FIGURE 11. APPEARANCE OF AM265 ALLOY PANELS FINISHED WITH THREE COATS (*left*) AND TWO COATS (*right*) OF ALUMINUM PAINT OVER THE PRIMER AFTER ABOUT 3-YEAR EXPOSURE ALONG THE SEA COAST

used on the other two panels.

The primers used on panels M402A and M406A form considerably thicker films than is obtained with a P27b-type primer, which is a thin quick-drying material containing the dispersion-type resin. This undoubtedly accounts, in part, for the greater durability obtained with the shorter oil phenolic-type systems. Figure 9 showed that aluminum paint made with the 20-gallon varnish gave more protection over a zinc chromate primer made with the same vehicle than over a P27b-type zinc chromate primer. Table I gives data on the moisture permeability of several different painting systems used on magnesium alloys, employing the method described by Wray and Van Vorst[10].

As already noted, the comparisons made in the accelerated test in the alternate immersion equipment were in good agreement with those obtained on the seacoast land racks at Point Judith. With the more permeable coatings the time required for incipient failure is shorter in the alternate immersion test than at Point Judith; the ratio is sometimes as high as 1 to 50. With the better coating systems applied to the more corrosion-resistant alloys, a much smaller ratio has been found; it is usually about 1 to 12. The important point, however, is that in any given test the order of failure in the two types of exposure has been found the same.

In the alternate immersion test some of the more durable painting systems on the more corrosion-resistant alloys have shown but little failure after 15 or more weeks of exposure. Similar systems on the same alloy were in good condition after 3.5-year exposure on the seacoast land racks at Point Judith. Several panels of AM265 magnesium alloy castings painted with the more durable finishes are shown in Figure 11 after about 3-year exposure at Point Judith.

In inland industrial atmospheres, such as at New Kensington, Penna., paints protect even better than in seacoast environments, as might be expected. After 5 years outdoors at New Kensington, panels similar to those exposed at Point Judith (Figure 11) had shown no failure; thus, with satisfactory protection, long life may be expected of magnesium alloys used under normal industrial atmospheric conditions.

TABLE I. MOISTURE IMPEDANCE OF VARIOUS PAINT COATINGS USED FOR THE PROTECTION OF MAGNESIUM ALLOYS

Paint Coating	No. of Finishing Coats	Moisture Impedance[a]
Zinc chromate primer (20-gal. phenolic resin varnish) + Al paint[b] in same vehicle	3	52.8
P27b-type zinc chromate primer + Al paint in 20-gal. phenolic resin varnish	2	32.7
	3	47.4
P27b-type zinc chromate primer + light gray enamel made with 33-gal. phenolic resin varnish	2	18.4
	3	20.2

[a] Moisture impedance = (area of film in sq. cm. × hours)/(mg. of moisture penetration). Test conducted at 80° F. with dry air on one side of film and air at 95 per cent humidity on the other side.
[b] Made with 2 pounds of aluminum paste per gallon of vehicle.

Summary and Conclusions

The accelerated exposure test, comprising cycles of immersion in synthetic sea water combined with atmospheric exposure at an angle of 45° to the vertical facing south, has been found a reliable means of quickly obtaining a measure of the relative durability of various protective coatings on magnesium alloys. Any particular painting system will appear to give the best protection on the alloys which are most resistant to corrosion. Resistance to corrosion is largely determined by alloy composition.

A satisfactory surface treatment is important. Of the various treatments tested, the chrome pickle followed by dichromate sealing and the HF-dichromate coating proved to be about the most effective both from the standpoint of protection and as bases for paint coatings.

Selection of the proper priming coat is also important. Zinc chromate primers made with phenolic resin varnishes of short to moderate oil length were found to be most effective, although primers of the well known P27b zinc chromate type gave good results. Aluminum pigmented finishing coats gave the best protection; the most suitable vehicles were the phenolic resin vehicles of moderate oil length. Finishes of this type in which both primer and top coat were made with the moderate-oil-length phenolic resin varnish have shown little failure on the more corrosion-resistant alloys after 26-week exposure in the alternate immersion test.

The order of failure of various coatings in the alternate immersion test agrees very well with that obtained in tests at the seacoast, although failure occurs much more slowly in the latter environment. With the best finishing systems, satisfactory protection has been obtained on the more corrosion-resistant alloys for periods up to 3 or 4 years in tests at the seacoast. In industrial atmospheric tests even longer periods of protection have been secured; in the latter case some of the experiments have been under exposure for 5 or 6 years without showing noticeable signs of failure.

The tests have shown that it is possible, by proper selection of alloys and painting systems, to obtain durable protection on magnesium alloys, comparable to that secured on some of the other light metals.

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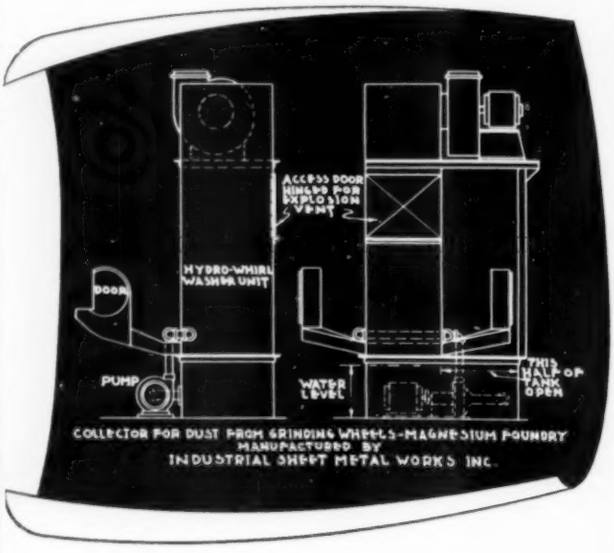

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It's Easy TO INSTALL INFRA-RED WITH GIFFORD-WOOD ON THE JOB

Gifford-Wood can provide you with designs for any Infra-Red Baking and Drying Installation, and custom-build NI-R conveying systems for your operations.

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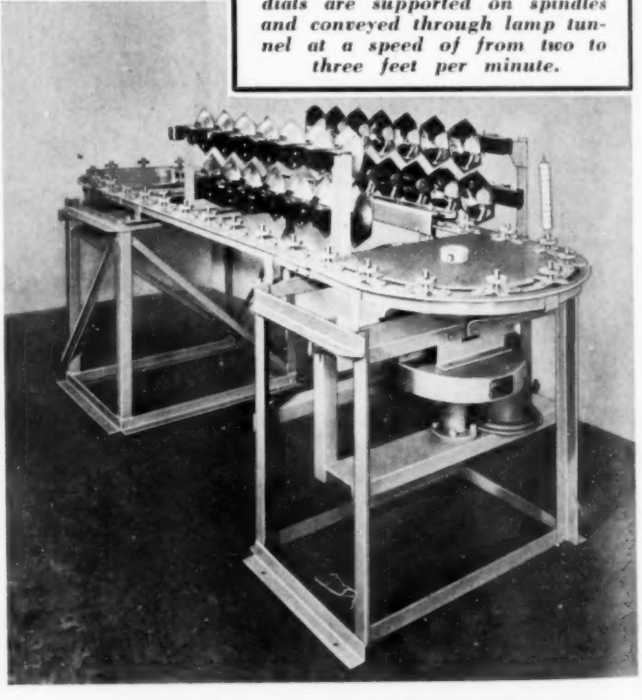
Special Gifford-Wood NI-R Conveyors, properly equipped by experienced G-W engineers, automatically integrate coating, drying, baking, cooling operations, enable you to derive the maximum benefit from the newest Infra-Red technique.

Write for bulletin describing and illustrating complete G-W installations, enumerating advantages and savings.

A small NI-R Conveyor for baking on a finish of synthetic lacquer. Small counting machine dials are supported on spindles and conveyed through lamp tunnel at a speed of from two to three feet per minute.



GIFFORD-WOOD CO.

Founded 1814

New York 420 Lexington Ave. | HUDSON, N. Y. | Chicago 565 W. Washington St.

FINISHING OF TOOL PARTS

By PHIL. PETERS

Foreman, Finishing Dept.,
Independent Pneumatic Tool Co.,
Chicago, Ill.

AMONG the important smaller tools required in the furtherance of the National Defense Program are the portable power tools. One not familiar with the inner workings of these comparatively small yet powerful tools, would be surprised to learn that in the production of the large line of air- and electrically-driven portable tools made by the Independent Pneumatic Tool Company, at its Aurora (Illinois) plant, some 33,000 separate and distinct parts are required, many of which are subjected to special finishing processes. Necessarily there are a number of finishing processes, including various forms of plating, grinding, polishing, and spray painting.

It would be impossible to go into details regarding all the finishes required for these thousands of parts, though this is not to say that all of the 33,000 require special finishes. A few examples, however, of those to be finished may be given. For instance, there are hammer barrels and rivet sets for hammer tools, which are cadmium plated for the purpose of rust proofing and also to enhance the appearance of the tool. Hose couplings for the same reasons are galvanized. In handling these hammer barrels, after first giving them the necessary preliminary cleaning, they are placed between the jaws of specially made clamps attached to a rod, and then passed through the dipping solutions and rinse, a commercial plating preparation being used.

Other parts, because of their size and shape, are placed on specially designed racks, as in the chrome plating of trigger pins for hammers, which are each placed separately in a pincher type rack. Rotary tool valves are handled much in the same way for chrome plating.

A number of other parts entering into the assembly of these tools are copper plated. In the case of the subassembly of the pressed steel piston and connecting rod, used in air tools, the connecting rod is copper plated all over, except the surface around the hole, which is left free of copper so that this (a wearing surface) will be hardened when the assembly later is subjected to heat treatment, to make it wear resistant. The piston, on the other hand, is copper plated on the inside, with the outside surface left in proper condition for hardening by heat treatment. The bearing, of the same steel as the piston and connecting rod, carrying the connecting rod and riveted to the inside of the piston, is copper plated on the outside, leaving the bearing surface hardened after heat treatment. Here also, in the plating department, all aluminum parts are washed and otherwise cleaned, while certain steel parts are dipped in oil. Commercial solutions are used throughout the plating department, and are tested every day.

Such parts as require blast cleaning before being finished, are sent to the blast cleaning room, where the larger pieces are handled in an abrasive table

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That's all we need, too. Just an inkling of your particular problem and, chances are, there's a formula in our research files that answers it EXACTLY. It's just as easy as that. You're handling Stanley Finishes every day . . . on all sorts of products . . . probably on products in your own field. A postcard will bring proof of what Stanley Finishes can do for YOU. Or, if you insist upon getting in your three "scents" worth, address the envelope to Department K.
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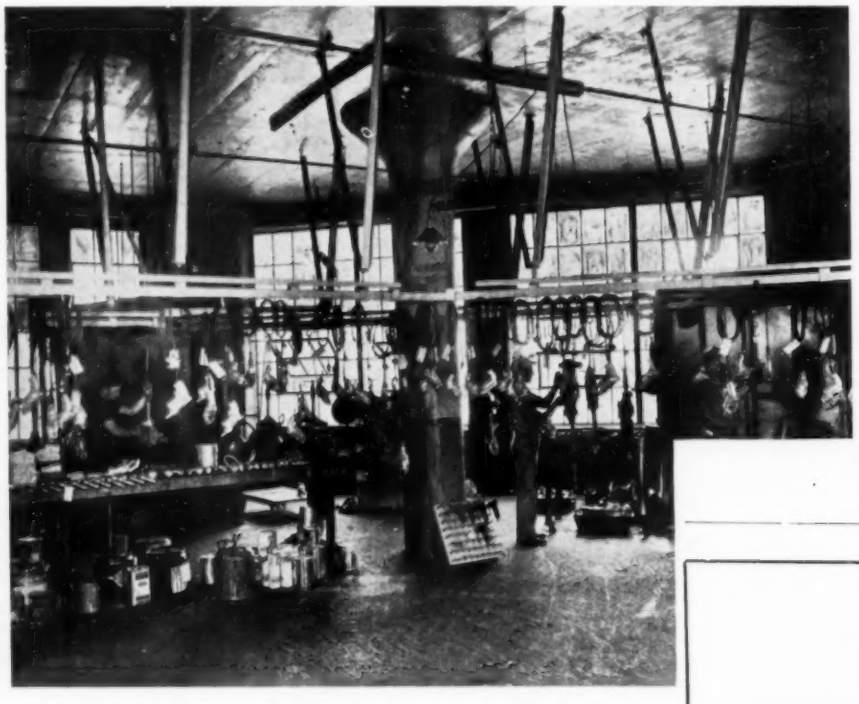
type blast cleaning machine, using steel grit; while the smaller parts are handled in a tumbling barrel.

Down the long row of machines in the grinding and polishing department is a constant flow of shop pans filled with parts requiring various grinding and polishing operations. For instance, relief on all shoulders are ground smooth by internal and external grinding so as to remove any rough tool marks, thereby eliminating the possibility of the formation of cracks, which may result in the failure of the part. All forgings on handles are rough ground, after which they are given magnaflux tests for surface cracks and seams, and then machined and polished. In this department a large variety of wheels as to size and fineness are used. For polishing, felt wheels, set-up with emery are used. The setting up of all polishing wheels is taken care of by one man, who at the end of the day re-emeries them and makes sure that the wheels are properly balanced. In setting up the wheels he re-coats them with a good quality of hide glue in the usual way, then rolls them in the abrasive and places them in a drying oven. The next morning they are again ready for use.

The thousands of parts, moving through the production, cleaning, grinding, plating, and polishing departments in stock pans, are each given a thorough inspection after each operation, and another final inspection before being sent to the finished stock room, from where they eventually find their way to the assembly department. After assembly, all tools are immediately sent to a sound-proof testing room, where they are kept in constant operation for a period of twenty-four hours, after which those using low frequency current are given a test of 1100 v., while the high frequency tools get 2200 v. Thereupon they are hung on hooks suspended from an overhead trolley which takes them to the final



General view of paint finishing section, showing wash booth on the left and portable tools traveling towards first spray booth.

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S-310 is now used by many manufacturers of hand tools, e.g., hatchets, shears, pliers, axes, auto wrenches, etc.; for hardware of the better grade; for the bright metal surfaces of machine tools.

S-310 is indicated wherever a thin, hard, non-greasy film that resists rust in transit and storage is desired.

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Cleveland, Ohio

inspection point for the assembled tools, and from there through a cleaning section where they are given a hand washing with solvent. In the brightly illuminated paint department, where fluorescent lamps furnish the lighting, there are two spray booths. At the first the tools receive a prime coat. From there they proceed to the second to receive the final color spraying of soy bean lacquer.

Tools manufactured at this plant fall into one of four classifications, and each classification is given its distinctive color, unless otherwise specified by a customer. Universal tools are given aluminum paint; pneumatic tools, green; contractors' tools, red; and high frequency, a dust-proof gray. Customers desiring special colors may have whatever color may be preferred. For instance, one of the large railroad companies specifies a certain shade of green for all its tools; while one of the large automobile manufacturers requires its tools to be red; still another automobile manufacturer wants a light blue. Pressure tanks are used for all spray painting.

After the final spray coating, the tools proceed slowly on the trolley conveyor, having ample time to dry before arriving at a gravity roller conveyor, where they are removed from the overhead trolley, placed in shop pans which have previously been lined with paper to prevent the tools from being scratched, and from there are allowed to glide down the roller conveyor and into a spiral chute, which takes them to the shipping room on the floor below.

Patent Digest

Coating Composition

U. S. Pat. 2,252,486 M. H. Arveson, assignor to Standard Oil Company, August 12, 1941. A composition capable of forming a flexible, glossy, flame-resistant and waterproof coating comprising an organic solvent and a mixture of a hard brittle, highly chlorinated polymer of unsubstituted isobutylene containing between about 45% to about 65% chlorine and normally insoluble in the said organic solvent and a chlorinated diphenyl plasticizing agent compatible with the said chlorinated polymer of isobutylene, said chlorinated diphenyl containing at least 25% chlorine the mixture of said chlorinated polymer of isobutylene and the chlorinated diphenyl plasticizing agent being dissolved in the said solvent.

Portable Degreaser

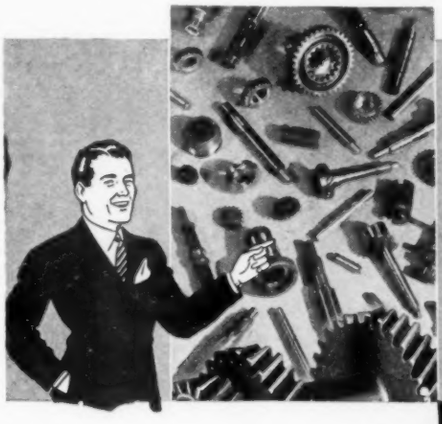
U. S. Pat. 2,253,579 W. D. Phillips and R. A. Van Fossen, assignors by direct and mesne assignments to The Dow Chemical Co., August 26, 1941. A portable vapor degreasing apparatus of novel design, using the thin heat conducting side walls of the vapor chamber as the sole condensing means.

Coating Composition

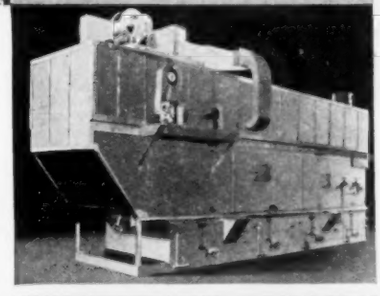
U. S. Pat. 2,257,281 H. A. Scholz and E. B. Oberg, assignors to the United States Gypsum Co., Sept. 30, 1941. A water-paint composition comprising mica, a water-insoluble fatty acid soap, a water-soluble phosphate and a proteid binder.

Coating Composition

U. S. Pat. 2,257,280 H. A. Scholz and E. B. Oberg, assignors to the United States Gypsum Co., Sept. 30, 1941. A stabilized paint composition comprising a highly purified vegetable protein, an alkaline solvent therefor, and a stabilizer selected from the group consisting of the alkali metal salts of aluminum, vanadium, tin and lead, said composition having gel-like characteristics when quiescent and possessing thixotropic properties, the stability of said composition having been enhanced by heating of said protein and solvent for about 15 minutes between approximately 170°F. and approximately 210°F.



Efficient Cleaning Of ALL Metal Parts

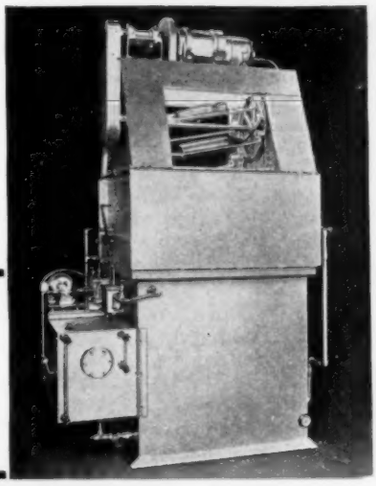


DETREX Degreasers and Washers are engineered to meet specific metal cleaning requirements. Equipment is designed to handle parts of every size and description.

For example, if the cleaning is to be done between production operations, prior to plating or in preparation for inspection, the machines are built to be efficient units of the departments in which they are used.

If your production—like that of hundreds of other plants—is turning rapidly to the manufacture of armament parts, you are undoubtedly faced with many new metal cleaning problems. The answer to them can always be found in the use of Detrex products—Degreasers using stabilized safety solvents Perm-A-Clor and Triad . . . Detrex machines for Alkali, Spirits and Emulsion Cleaning . . . and Triad alkali compounds, strippers and emulsion cleaners.

Write for literature or free engineering consultation.



● Above: Detrex processing machine incorporating alkali wash, chromic acid dip, hot water rinse and overhead drying oven.

● Right: Special design spray type Detrex Degreaser — for the production cleaning of shells.

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NEW EQUIPMENT AND SUPPLIES

LATEST COMMERCIAL DEVELOPMENTS IN ORGANIC FINISHING

Addition Agent to Prevent Greening of Lacquers

Advance Solvents & Chemical Corp., 245 Fifth Ave., New York, N. Y., have announced a material called Stabilisal "B", which is recommended as an addition to clear metal lacquers to prevent greening of the lacquers in the dipping tank. In addition, it is stated that the addition agent restores original color of lacquers already turned green.

The amount of Stabilisal "B" to use depends upon the condition of the cellulose nitrate, the acidity of the resins and solvents present, and on the ease with which the solvents hydrolyze. Usually, one part of addition agent to 400 or 500 parts of lacquer is satisfactory.

The material is a liquid and is readily measured out and mixed into lacquer.

Prices and information are given on a sheet which can be obtained from the Advance Solvents & Chemical Corp.

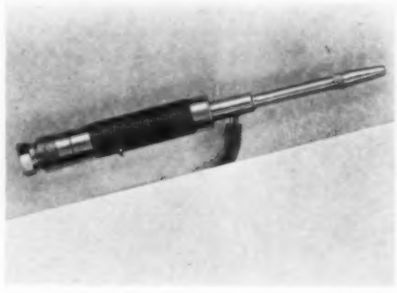
Cleaner for Army Lustreless Paint

A low-cost, quick, and effective oil and grease cleaner for removing shine as well as dirt from the Army lustreless paint surfaced vehicles and ordnance is recently described by A. F. Curran, Research and Development Chemist for the Curran Corp., Dowling Bldg., Malden, Mass., as a new high-boiling safety solvent, having unique self-emulsifying properties when associated with water. Application is suggested by means of low-pressure spray or brush. Automatic emulsification of the dirt or wax is said to take place when the treated surfaces are rinsed by sluicing with a water hose. It is also stated, no film is left to cause glossing, and this is evidenced by the even "wetting" or "sheeting out" of the painted surfaces by the water rinse. On drying, the vehicles assume a clean, dead-flat appearance without harmful effect to the painted surfaces.

Engine and Parts Cleaner

Davis & Murphy, 500 N. Dearborn St., Chicago, Ill., have announced the sale of their Model G.W. engine and parts cleaner, which is stated to be an improved spray gun for applying kerosene and other cleaning fluids with compressed air.

The gun contains no springs, levers, push buttons or packings. It can be easily and quickly taken apart and reassembled for the purpose of cleaning. It is simply attached to the air supply. The feed hose is dropped into the fluid tank and slight pressure is exerted on the nozzle end. The



Engine and parts cleaner.

flow of both air and liquid is immediately automatic.

The gun can also be used for blasting with compressed air by simply removing the fluid tube from the fluid and operating the equipment as a blow gun. The gun is being used for general cleaning of engines and large metal parts as well as for cleaning objects to be subsequently painted or enameled.

The hose is made of Neoprene and is impervious to the action of most solvents and other cleaning fluids.

Synthetic Rubber Hose

A new type hose for all standard paint and lacquer spraying equipment, with the tube built of Ameripol, its own type of synthetic rubber developed in its laboratories, is announced by The B. F. Goodrich Company, Akron, Ohio. The new line replaces the company's lacquer hose and its "Mainstay" line of paint spray hose.

The new hose is made in inside diameters of ¼, 5/16, ⅜ and ½ inch and outside diameters of ½, 39/64, 11/16 and ⅞ inches, all standard dimensions for standard paint and lacquer spraying equipment.

In the ½ inch inside diameter size construction will be two-braid while in the other sizes it will be one-braid, made of heavy high tensile cords. It is capable of being used as air hose with an ample margin of safety.

Tube is a black, oil-resistant compound, while working pressure for all sizes is 150 pounds maximum.

With the addition of the new hose to its line, B. F. Goodrich now has a full range of synthetic rubber lined hose from ¼ inch inside diameter to the 10 inch inside diameter Type 400 oil hose.

Protective Covering for Wall Paint

A washable protective covering for flat wall paint, designed for use in drafting rooms, plants, warehouses and offices where it is desirable to provide for easy cleaning of painted walls, has been announced by The Bergonize Company, Merchandise Mart, Chicago.

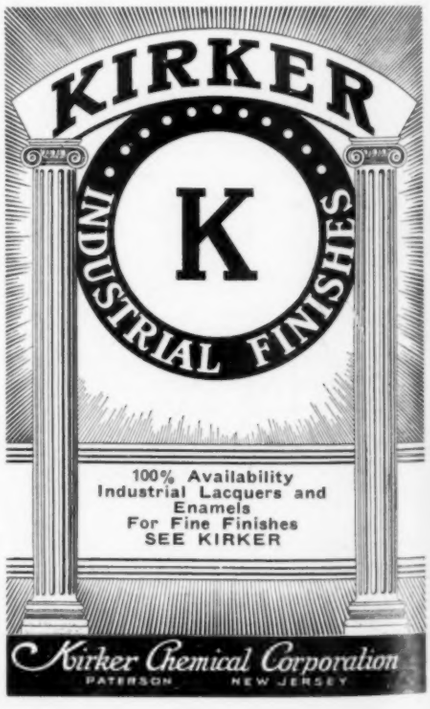
The product may be applied over a newly painted or over a cleaned wall, and provides a clear, transparent, flat protective film that prevents dust, dirt and grime from penetrating the pores of the paint. Odorless, it dries flat within 20 minutes at 70° F., and possesses high ability to reflect and diffuse light. One gallon covers approximately 1500 square feet.

Bergonize is removed from a protected surface merely by application of clear water with a sponge or rag, taking with it all dirt and leaving the surface in its original paint-clean condition. It is not recommended for use in rooms where an extensive amount of steam escapes into the air, or where condensation takes place on the walls or ceiling.

Uses of the product are described in a 6-page folder, "As If By Magic."

Spray Painting Air Compressor Outfits

The DeVilbiss Co., Toledo, Ohio, have issued a 4-page folder describing two new series of spray painting air compressor outfits. These outfits contain gasoline engine, air compressor and air tank, all mounted on a compact assembly. Various capacity outfits may be obtained, mounted on two or four wheels or on a metal frame as a skid outfit.



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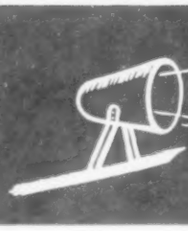

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They're time-consuming and labor-wasting—those burring operations as now carried on in many plants with bench after bench of workmen removing excess metal with hand files, burring tools, emery cloth, etc. And it's a tricky job to maintain proper tolerances and measurements when using such tools.

The LEA Method, now in use in a number of important plants manufacturing materials for defense including plane and engine parts, machine gun assemblies, etc, embodies the selection of the ideal combinations of special types and shapes of buffing wheels with the proper grades of Lea Compound.

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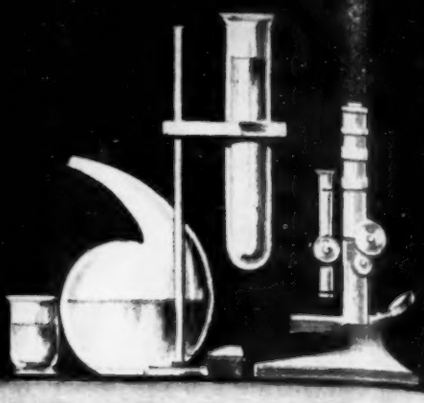

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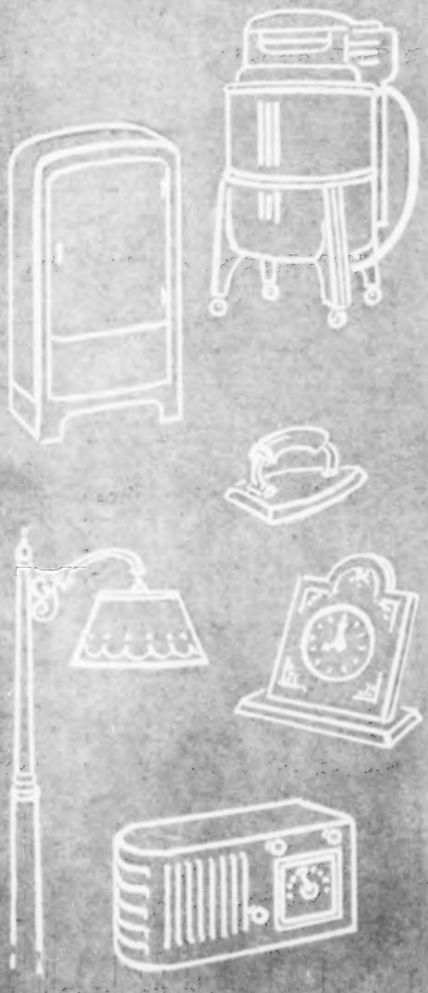
FOR CIVILIAN AND DEFENSE MANUFACTURING



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METAL FINISHING (formerly Metal Industry) has been the leading publication since 1903 in the field of metal preparation, electroplating and coating.

Yes, there must be very good reasons for the constantly growing volume of *REFININGS* shipped to Handy & Harman and the steadily increasing number of manufacturers who *regularly* send their scrap, sweeps and other waste to our refining department.

Many who regularly entrust their gold, silver and platinum scrap and waste to us are sending *more* and *bigger* shipments. Others, knowing our reputation for dependability, send their shipments because they now have more at *stake*.

Most significant is the fact that shipments from the *Mid-West* and *Pacific Coast* are growing rapidly too. Some even ship by boat and are willing to wait to get the highly accurate returns we do everything possible to give.

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VOL. 39, NO. 12 METAL FINISHING DECEMBER, 1941
PREPARATION, ELECTROPLATING, COATING

Save Finishing Materials

THE plating and finishing industry is faced with shortages of almost all materials and supplies normally used. The struggle to keep the finishing plant going has placed a heavy strain on the plater's patience and ingenuity.

As stated before, we believe American industry including the plating industry, has been wasteful of materials because labor costs were reduced at a sacrifice of material consumption. The trend to faster production lead to higher current densities with higher power loss from poorer conductivity of hot bus-bars, from higher anode and cathode polarization and from lower cathode current efficiency. All this meant increased waste in material—more power means more material—coal or oil required.

The very concentrated solutions used for cleaning, pickling and plating mean greater drag-out loss, greater spray loss and frequently faster decomposition or consumption of material. We have seen alkaline cleaner tanks so concentrated in cleaning material that precipitation of cleaner occurred when the solution cooled at night. Concentrated acid solutions are used where more dilute solutions would work as well or better.

Some suggestions for conserving materials in plating follow:

Cleaning: Use the concentrations recommended by the vendor or found best by you and control the cleaner by titration—a very simple procedure. Too highly concentrated cleaners, particularly non-electrolytic cleaners, frequently clean more poorly than more dilute solutions.

If using solvent and/or vapor degreasing make certain that the heating and cooling systems are balanced. Large volumes of work placed into small vapor cleaning tanks may force out cleaning vapor before it can be condensed. Avoid strong drafts near surface of tank and lastly make certain that the work is racked so that it will not bucket out the solvent. Special rotating baskets are available for degreasing cup-shaped objects.

Pickling: Control pickles also by titration. Use inhibitors to reduce attack on steel, surface active material to reduce drag-out, and save acid. Do not transfer work from alkaline cleaner directly to the acid without rinsing—this is very wasteful of acid.

Plating: Control solutions regularly by analysis.

Use auxiliary anodes to get more uniform plate and save on plating thickness. This can be done in still tanks and certain automatic machines specially equipped. For general plating of irregular shapes on automatic equipment the principle of an intermediary electrode can be used. This involves fastening a piece of metal to the rack and placing it in the path between the work to be plated and the anode. The metal is insulated from the rack and tends to equalize current distribution on the work by lowering the total electrical resistance from the anodes to the recessed portion of the cathode.

Insulate the plating racks.

Use bright plating solutions to obviate the need for buffing of the deposit. Tests have shown that from 8 to 15% of the deposit is removed in buffing to high luster.

Save drag-out of solutions by careful attention to racking to give proper drainage, use reclaim rinse tanks and do not run solutions more concentrated than is necessary.

A great loss in materials can be occasioned by rejects. Try to impress upon the engineering department that proper design in regard to plating can help greatly in making plating easier and with less rejects. Parts designed with sharp corners, ornamentation, deep recesses, rolled beads, and joints difficult to rinse, make plating more difficult.

Defense Highlights

Priority orders on sheet steel, produced in the Cincinnati area, consumed almost 80% of the sheet steel output from this area, leaving only a balance of 20% of the steel to supply civilian demands.

The ban on the use of bright finish or trim on passenger cars has been extended from December 15th to December 31st, 1941, under an order issued October 27th. This will give manufacturers a longer time to use up stocks finished or in process as of October 27th. Certain items, such as screws, locks and windshield wiper blades will probably be exempt because it is difficult to substitute other finishes for plating on these objects.

Passenger automobile production in February 1942 will be restricted to 43.9% of the output of the month of February of 1941.

Titanium dioxide used as a pigment has been placed under a monthly allocation system under General Preference Order M-44 released November 22, 1941. The order became effective December 1st and it is to set up a defense pool to take care of all mandatory orders and to prorate the remainder on an equitable basis to all customers. The defense pool for the first month is set at 20% of each producer's daily production. Titanium dioxide is produced from ilmenite ores which are largely imported from India.

Lead and tin foil will no longer be used after March 15, 1942, for packaging a number of products, including cigarettes, chewing gum and candy. These foils come under Limitation Order No. L-25 issued November 24, 1941.

The chlorinated rubber production capacity of the Hercules Powder plant at Parlin, N. J., will be enlarged. The enlargement of plant facilities to be completed in February 1942 is hoped to increase production of Hercules chlorinated rubber by nearly 50%. Hercules chlorinated rubber is sold under the trade name of "Parlon".

A plan to relieve anticipated unemployment among 7,000 employees in the metal plating industry recently hit by priority orders has been suggested by OPM. The plan proposes that: "1. No new plating plants or facilities to be built as long as there are plants and facilities available. 2. The pooling of facilities on both an industry-wide and geographical basis in order to obtain defense contracts or subcontracts. 3. An industry-wide study to be made in cooperation with the OPM to ascertain how the industry's facilities may best be adapted to production conforming with Army and Navy specifications. 4. Investigation of the extent to which the curtailment order will affect the employment in the industry with a view to preparing for possible future revision of the curtailment order."

A bomber requires 500 lb. of copper, a single seat fighter plane uses 5000 lb. of aluminum and a 30-ton bomber requires 20,000 lb. of aluminum—enough to make a few saucepans.

Plants to produce synthetic phenol are being built including a new $1,000,000 plant of the General Electric Co., Pittsfield, Mass. Phenols are used in large amounts to make plastics and the proposed General Electric plant, to be in operation September 1942, will produce about 75% of the General Electric Company's requirements of phenols.

Phenols and allied products were placed under complete allocations control under an amendment issued to General Preference Order M-27 released November 10, 1941. The Director of Priorities after December 1, 1941, will give specific directions each month as to shipments of phenols.

Cobalt and cobalt chemicals were placed under a direct allocation system to be administered by Director of Priorities under General Preference Order M-39. Monthly requests for cobalt shall be filed on forms prescribed by the Division of Priorities. 1500 of the 1700 tons cobalt now produced annually in the United States come from ore imported from Africa. Cobalt is used in high speed cutting steels, in paint dryers, vitreous enameling and in plating.

Chlorinated rubber used in making alkali and acid resisting paints and other products was placed under rigid priority control under General Preference Order M-46, released October 29, 1941.

CLEANING AND BRIGHT PLATING STEEL PARTS OF ELECTRIC IRONS †

BY F. A. MAURER

Engineer of Processes,
General Electric Co., Ontario, Cal.

Preface

THIS paper was written and read before the Los Angeles Branch of A.E.S. before the shortage of nickel for defense purposes caused the restriction of its use in electroplating.

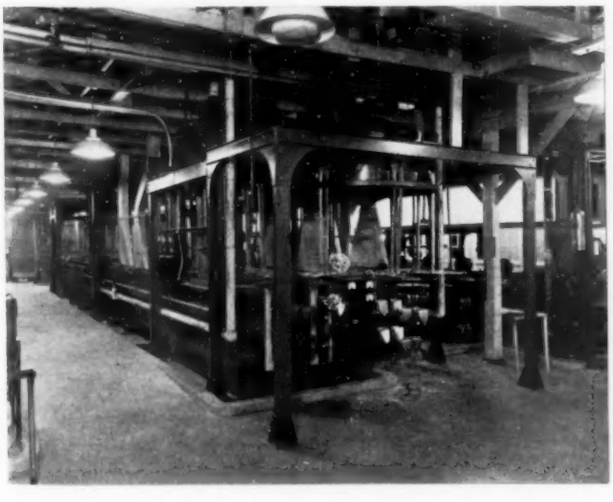
Our practice has, therefore, been modified to conserve nickel, without reducing corrosion resistance or appreciably affecting appearance. This result can be accomplished in two ways, both of which are employed on our several parts.

First, the parts, made of either steel or cast iron, are much more highly finished prior to applying nickel, thereby requiring very little cut-down buffing of the nickel. In other words, what nickel is applied is left on the part, doing little more than color buffing before applying the chromium plate.

Secondly, the parts, whether steel or cast iron, may be less highly polished, first applying heavy copper which is cut-down buffed and color buffed, and a very thin coat of nickel applied. Parts are again color buffed before chromium plating.

As indicated above, we use both methods, even though the cost is somewhat higher, in order to spread our supply of nickel, under the Defense Program, over a large number of appliances.

The paper is still applicable as describing methods for cleaning iron and steel parts and putting a copper, bright nickel and chromium coating on.



View, from loading end, of automatic equipment for bright nickel plating of steel and cast iron in the General Electric Co. plant at Ontario, Calif. Cleaner tank is on right side; drier on the left; nickel tank is at extreme end of machine, on the left side of picture.

At the Ontario, Cal. plant of the General Electric Company we have been producing electric irons for over 30 years. The processing of steel and cast iron parts in our finishing department has undergone a gradual evolution and steady growth, until last year, as an example, we plated with copper, bright nickel and chromium, well over three-quarters of a million square feet of surface.

In common with others in the same business, we used to apply a very thin coat of nickel directly upon steel out of a "double salts" cold nickel solution. Then came the warm Watts solution and much faster deposition, with resultant greater protection. The cyanide copper cleaner came about the same time and then the transition from manual operations to semi-automatic. Chromium plating in a full automatic machine came in 1931. Finally, bright nickel plating in fully automatic equipment was begun.

Our current practice in cleaning and plating must necessarily take cognizance of four main types of parts: (1) highly polished cast iron bases, (2) partially polished tops, drawn from high grade No. 3 finish cold rolled steel, (3) the smaller steel stampings such as handle supports, which receive a plate without preliminary polishing or burnishing, and (4) very small pieces such as screws and nuts, which are barrel nickel plated, but not chromium plated.

These parts follow various paths in their converging course toward the finishing room. Castings come in a straight line from the foundry, through five specially built milling machines which do all milling, drilling, tapping and part of the polishing. The XLCR machine, next, with ten wheels in line, polishes the bottoms, with just one pass through the machine. Next, the hand operations of rounding the corners and beveling the bottom edges is done by a group of skilled polishers. The men do their own inspecting, and only a spot check of their work is made by an inspector.

Polishing

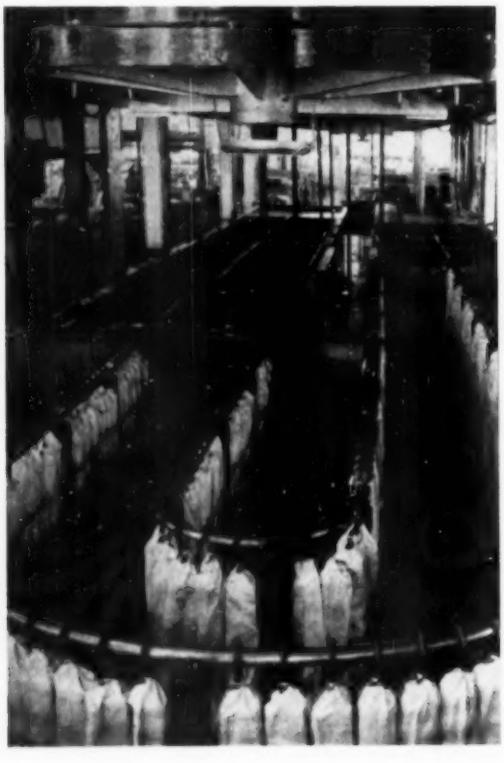
Lubricants in the drilling, tapping and polishing operations are carefully selected with the object of ready re-

† Presented to Los Angeles Branch, A.E.S. and published in "Monthly Review", Sept., 1941.

moval in the cleaning prior to plating. Either soluble oils or readily saponifiable grease such as stearic acid or tallow are used.

Tops are blanked out of No. 3 finish cold rolled strip steel, drawn, trimmed and holes pierced. In most dies, the light mineral oil on the steel as received is sufficient lubricant. Occasionally, a saponifiable grease such as lard is used. Draw marks are left on the sides of the tops where the stock has slid past the die. The die marks are removed by passing over two grades of built-up emery wheels—No. 120 and No. 180, on automatic polishing machine heads. Tops are placed on the polishing head, and removed by an operator who feeds two such No. 120 heads and two No. 180 heads. Tops are held against the rotating wheel while they themselves are being rotated with the polishing grain—that is, work goes down with the wheel—and at the same time an oscillating motion is imparted to the polishing wheel. A narrow band about one inch wide is polished from the bottom edge up. No hand finishing is necessary and no polishing is done on the upper portion of tops.

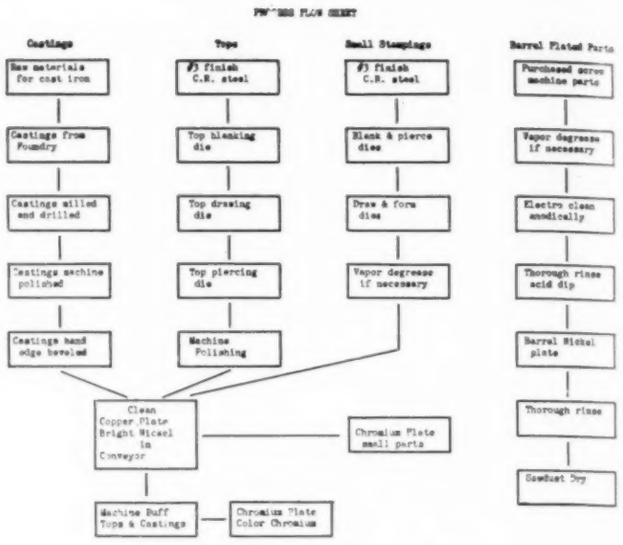
Small steel stampings for duty on exterior surfaces are as a rule handled direct from press room. There is ordinarily just a light coating of mineral oil on these parts, which the alkali cleaners can successfully remove. However, in some cases of punching heavy gauge stock, a heavy sulphurized oil must be used to keep the cutting



View showing nickel tank on end of machine opposite loading end.

Carriers not on track except over drier in upper right hand corner.

Tanks are numbered from the corner opposite drier toward nickel tank, and then from nickel tank toward drier. Nickel tank is No. 9.



COMPOSITION OF SOLUTIONS

BARREL NICKEL

Electrocleaner	Acid Dip	Barrel Nickel Solution
1. Sodium Sesquisilicate 5 oz./gal. 2. Sodium Hydroxide .5 oz./gal. Temperature 210° F.	15% Hydrochloric by weight	1. Nickel Sulphate 16-20 oz./gal. 2. Ammonium Chloride 3-5 3. Boric Acid 3-5 4. pH 5.6-5.8 by glass electrode 5. Temperature 75° F.

CONVEYOR BRIGHT NICKEL -

1st and 2d Electrocleaner Anodic	Rochelle Copper	Bright Nickel Solution
1. Sodium Sesquisilicate 15 oz./gal. 2. Sodium Hydroxide 1.5 oz./gal.	1. Metallic Copper 1.75-2.25 oz./gal. 2. Free Cyanide 1.75-2.25 " " 3. Sodium Hydroxide 6-7 " " 4. Sodium Carbonate (not over) 8 " " 5. Rochelle Salts 7-8 " " 6. Sodium Hyposulphite - trace 7. pH over 13.5	1. Nickel Sulphate 30-5 oz./gal. 2. Nickel Chloride 7.8-8.2 " 3. Boric Acid 5 -5.5 " 4. Modifying Agent .045 gal./gal. 5. Non-Pitter .0025 " " 6. Brightener .00025 " " 7. pH 3.0 Electrometric 8. Temperature 130° F.

Hydrochloric Acid Dip	Sulphuric Acid Dip
15% Hydrochloric by weight	40% Sulphuric by weight

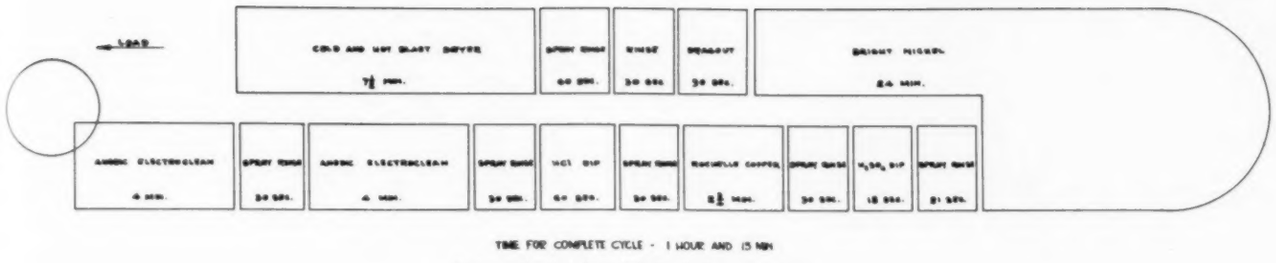
CONVEYOR CHROMIUM

Electrocleaner Cathodic	Chromium	Solution
Sodium Carbonate 2 oz./gal.	1. Chromic Acid 46-52 oz./gal. 2. Sulphuric Acid .66-.77 oz./gal. 3. Ratio CrO /H SO 66-76	4. Iron 0.20 oz./gal. 5. Trivalent Chromium 0.11 oz./gal.

edge of the die from breaking down. We have found it advisable to clean such parts in a solvent vapor degreaser prior to putting through the regular cleaning and plating process.

Small Parts

The fourth general class of parts we electroplate are small steel stampings for duty on the interior of the iron, bolts, nuts and screw machine parts. Interior parts get a protective coat of grey nickel in a barrel set-up. Certain parts for exterior duty are barrel plated, using a proprietary brightening agent in the barrel. Many of these parts have a coating of heavy sulphurized oil and must be degreased before going to the alkali cleaner. All small parts to be barrel plated are first cleaned anodically for fifteen minutes in an electrocleaner, operated at boiling temperature. After a very thorough rinsing, they are dipped in 15% hydrochloric acid, rinsed and emptied into the plating barrels for a two to three hour plate. Barrel solutions are operated at pH 5.6 to 5.8 by glass electrode; nickel sulphate, 16 to 20 ounces per gallon; ammonium chloride, 3 to 5 ounces per gallon; boric acid, 3 to 5 ounces per gallon. The solution running highest in solids content contains the brightener and is used for plating the exterior parts.



Automatic bright nickel plating conveyor.

Automatic Plating

All parts other than those barrel plated are cleaned and plated in a fully automatic conveyor. A complete description of the mechanical and operation features of the machine was presented last year,[1] and we will do no more now than to present a diagram showing the floor plan arrangement. As can be seen, there are now fifteen tanks in the arrangement, or two more than last year, because of addition of another electrocleaner and rinse. The addition of the second cleaner made the operation very much easier to keep free of oil and grease. I believe I can say the most critical tank from the grease standpoint is the sulphuric dip after copper plating. Perhaps that is because this dip will expose any faults of previous treatments. For instance, grease in tanks ahead of copper will be knocked off by the strong cleaning effect of the copper solution, and will accumulate in the solution as soaps or emulsified mineral oils. If not very completely removed from work surface by rinsing, such soaps and emulsions will be released as free fats and oils in the sulphuric acid dip and are quite prone to draw together into tiny circular areas on the copper surface, due to surface tension effect. Wherever such areas of grease occur, there will be no plate.

This phenomenon is similar to what has always taken place in dull nickel with oil droplets on the work and is what we used to call grease pitting. However, the trouble is much more pronounced in bright nickel because the droplets of grease tend to be absorbed by the solution, due to its low surface tension. In dull nickel, the solution exerted a prying off effect on the droplets, in many cases sufficient to remove the grease and permit plating.

It must not be inferred from the foregoing that the operation is causing us enormous losses in rework. Quite the contrary—we are justifiably proud of the low ratio of rework losses to volume of output. During the past three months, by way of illustration, the losses chargeable to nickel plating have averaged about 1.5% of the production. Poor cleaning was responsible for only one-quarter of this. Defective chromium plate on the nickel during the same period of time averaged about 0.75%. This good record is largely the result of close attention to all operating details by Mr. Weber, foreman, and Mr. Extale, analyst and control chemist.

Cleaning

Now, a word on the individual solutions. The sequence of treatments, and time in each is as shown on this chart. (See Chart 3). In all water rinse tanks, a gentle flow of fresh water is maintained, from bottom to top. They all are equipped with sprays which hit the work entering and leaving the tank. The valves are automatically operated electrically. Both electrocleaner solutions are of the same strength, 6-7 ounces sodium oxide per gallon, which is derived from 15 ounces sodium sesquisilicate and 1.5 ounces caustic soda per gallon. We have found the anodic cleaning best suited—a film is usually left on cast iron when cleaned cathodically. Laboratory check and additions are made daily. Current densities of 80-100 amperes per square foot are used.

Acid Dip

The acid dips are checked and additions made daily. The hydrochloric acid standard is 15% by weight and sulphuric is 40%. Action of hydrochloric acid on steel is unnoticeable; castings retain some heat from the cleaner and there is noticeable gassing, but no real pitting of the surface. It has been found that 40% sulphuric is needed to completely neutralize the cyanide film on the copper and obtain proper adherence of bright nickel.

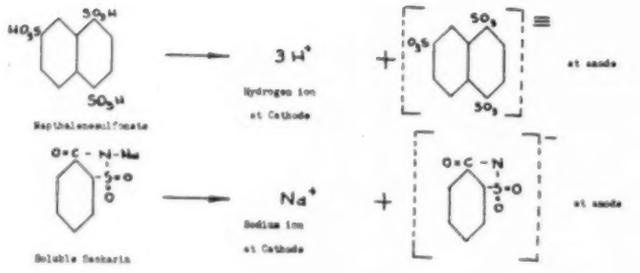
Copper Solution

Copper solution is checked for metal, free cyanide, caustic soda and Rochelle salts, and additions made daily. This solution we have found more difficult to keep operating properly than the nickel. When it is realized that this solution is operated relatively hot, at 150°F., and is 700 gallons only, and cyanide is constantly decomposing, it is seen that changes in conditions are greater than in the relatively stable nickel solution of 4,000 gallons with operations at 130°F. We have found the addition of a very small amount—hardly more than a trace—of sodium hyposulphite to be helpful in maintaining a bright plate. We also believe in keeping free cyanide high, and the sodium hydroxide content of 6-7 ounces per gallon brands this more as a cleaning solution than a copper plate. What we obtain in the tank is a good thorough cleaning action, with a flash of copper deposited to prove that the surface is clean. Current densities in the range of 30-50 amperes per square foot are used.

Nickel Solution

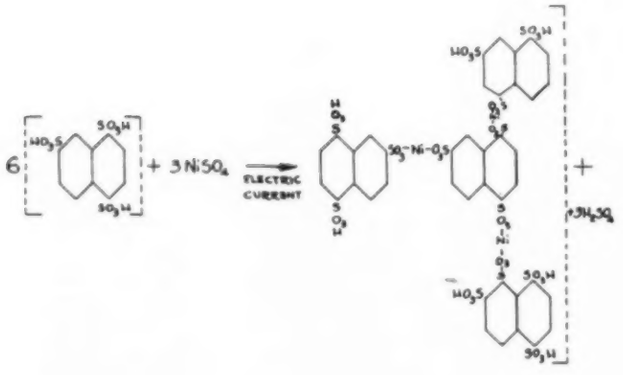
The nickel sulphate, boric acid and nickel chloride contents of the bright nickel tank are checked and additions made once a week. The organic materials present: sur-

1. Monthly Review, A.E.S. **27**, 346 (1940).



Explanation above would assume the modifiers or semi-brighteners behave the same as salts in solution, breaking up into ions which migrate to anode and cathode.

It is improbable that this is what actually takes place, because there would be a tendency to deplete the cathode region of the organic substance. To influence the plate, the organic radical should be concentrated at the cathode.

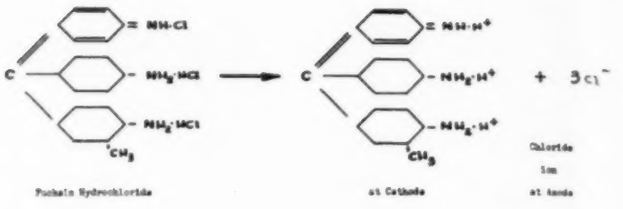


This is an attempt to show how sulphonated naphthalene in nickel solution can combine its molecules together to form huge particles of colloidal proportions. It is evident the diagram above shows just the starting of the process, since it can be repeated at each hydrogen atom, and molecules of the order of 50,000 molecular weight produced.

Such colloidal molecules adsorb an electric charge which helps propel them to the work surface where they influence the character of the plate. The charge is readiiy given up and probably no change in the structure of the colloid results.

face tension reducer, brightener, and the modifier or carrier for the brightener are checked and necessary additions made daily. Bright nickel plate is subject to roughness from anode carbon or metal particles, coming through tears in the anode covers and constant policing of the bags is necessary. Continuous filtration through filter paper backed by canvas cloths in a rubber covered filter press helps to keep rough particles out and maintain a crystal clarity of the plating solution.

Since the ductility of the plate and susceptibility to double plating of nickel are influenced by brightener content, we maintain as low a level of brightener as will give us the required lustre. On small, unburnished, unpolished stampings, the No. 3 finish is so good that the low level of brightener still gives good lustre. On polished tops and castings, the polish marks showing, make necessary a cut-



This explanation of the probable action of the extreme brighteners of which Fuchsin is an example seems reasonable.

It is known that compounds of this type, in weak acid solution such as nickel, are strongly polar, and split into ions.

It is known that this compound is consumed in proportion to the amount of current passed. Therefore the compound either becomes a part of the plate, or perhaps more probably is destroyed or changed in properties at the work surface.

down buffing, and ductility is far more important than extreme lustre. We insure uniform flow of current to the parts by a spring contact between rack and carrier arm, and carrier arm and current bus bar, and the once serious peeling of nickel off nickel is now practically unheard of.

Extreme care is exercised to prevent stray currents through the lead heating coil. When a lead surface in bright nickel becomes anodic, it seems to provide ideal conditions for decomposition or oxidation of the surface tension reducer and the brightener. At times when our lead coil became anodic, a very marked increase in consumption of these organic materials was noticeable. At the same time, a smoky tone developed on the nickel plate instead of the usual clear lustre.

The standard method of ridding a nickel solution of waste organic products and oil or grease is to treat with activated carbon. If sufficient carbon is stirred into the solution, usually in a tank separate from the plating tank, practically all the surface tension reducer and brightener will be removed, in addition to waste products. Perhaps some of the modifier is removed but it is present in relatively large amount and its loss is not noticed.

It is good practice to periodically filter the solution through a press, the cloths of which have been coated with filter aid (or diatomaceous earth) and activated carbon. This serves to prevent any accumulation of waste products sufficient to affect the plate, and takes out oils or fats held in emulsion form by the surface tension reducer.

Mechanism of Bright Plating

It is of interest to speculate on what the mechanism of bright nickel plating really is. We are reasonably sure that the crystals of bright nickel are kept extremely small and of uniform size, and furthermore that they are made to develop on the surface in a definite orientation, that is. they are "made to lie down flat instead of standing up". It has been suggested that the nickel crystals may be kept under 0.0001 of a millimeter by the use of a material such as nickel naphthalene trisulphonate, which mechanically prevents formation of large crystals because its

large molecule becomes adsorbed on the nickel deposit.

It is claimed that mutually beneficial effects are obtained in bright nickel by the use of a "modifier" and a "brightener". The modifier is of the class of compounds mentioned previously—namely, a sulphonated naphthalene, or it may be derived from benzene and belong to the class known as "sulphonamides", and "sulphonimides", of which saccharin is an example. These regulating agents are said to exert a ductilizing effect on the plate and plating experience appears to bear this out. The compounds listed as brighteners cause extreme lustre on the plate, and also are the cause of brittleness when used in excess. When this, the extreme potency as well as singular effect of the brightener is recognized, little trouble with brittle plate is experienced. The brighteners belong to what are known as the triphenyl-methane dyes—one of which is Fuchsin, or a derivative thereof. The surface tension reducer may be sodium lauryl sulphate.

It will be of interest to consider possible reactions of the organic compounds in bright nickel. One explanation is as follows: The sulphonated naphthalenes are polar compounds—that is they can dissociate or separate in solution into "ions", one being hydrogen and the other the naphthalene molecule with addition of the sulphonic radicals. This large structure, of molecular weight 207, might be borne by the current to the anode whereas the hydrogen goes to the cathode or work surface. However, an explanation such as this does not seem very valid because the passage of current would tend to deplete the cathode region of the regulating agent, and its effect on the character of the plate—an effect which is dependent upon its presence at the immediate surface—would become less and less with passage of more and more current.

A more probable explanation is that the molecules of the sulphonated naphthalenes combine into very large aggregates. When polysulphonated naphthalenes are present in solution, the extent of such aggregation of simple molecules is almost unlimited, so that huge structures of the order of 50,000 molecular weight may be built up. The chemistry of such huge molecules is different from that of ordinary sized molecules. They are in the colloidal class of materials—familiar colloids are gelatin and glue. Particles of colloids are capable of picking up charges of electricity without being altered in their structure. The electric charge is simply superimposed on the original structure. When ordinary compounds in solution split into ions, there is an actual separation of the molecule, each portion of which then bears an electric charge sufficient to exactly neutralize the charge of opposite sign on the other portion.

The electric charge is instrumental in propelling the large colloid particle to the immediate vicinity of the electrode. Thus, in the case of the sulphonated naphthalenes, what probably takes place is that the colloid particle picks up a positive charge which helps to propel the particle toward the cathode and keep it concentrated in the immediate vicinity. When the colloidal particles are present at the actual surface where metal is being plated out of solution, they seem to prevent the growth of large crystals, causing the plate instead to be made up of a multitude of fine crystals. Also, there is reason to believe that certain compounds cause orientation of the crystals in definite planes. The reflectivity of the surface is much higher, since there is no disordered jumble of crystals to break up the light waves.

Probably the colloids are not deposited from solution, although several investigators claim to have found traces of sulphur compounds in bright nickel plate. Such traces may have been mechanically caught during the process of deposition. The electric charges which the colloid particles bear on their journey toward the cathode are given up at the work surface, probably without causing any change in structure.

The triphenylmethane dye type of brightener, on the other hand, is consumed in direct proportion to the concentration of it in the solution and the amount of current passed. This is because the compound splits up into ionic chlorine which migrates to the anode, and the large organic dye molecule—of weight around 300 which migrates to the cathode. Whether this complex actually plates out with nickel and becomes integral with the plate or is merely concentrated in the cathode film, is not for us to say. It would seem, however, that the extreme brighteners owe their effectiveness to this property of being concentrated at the cathode surface. The fact that these brighteners have to be added regularly in greater quantity than could be accounted for by drag-out means they are actually plated out, or changed by the plating process to ineffective compounds.

The amounts of these materials that are needed to plate nickel bright are extremely small. In a bath containing 32 ounces per gallon of nickel sulphate, 5 ounces of boric acid and 5 ounces of nickel chloride, for example, only 0.033 ounce of the surface tension reducer sodium lauryl sulphate, 0.53 ounce of the modifier, nickel naphthalene sulphonate, and 0.00067 ounce of the brightener, reduced Fuchsin, need be present.

Chromium Plating

So much for nickel plating. Steel tops and cast iron bases go from plating to automatic buffing equipment where a high polish is put on. After an auxiliary color buffing, parts go to the chromium plating section where they are racked on a separate conveyor. As the loaded racks are brought up to the plating machine, they are transferred manually.

A 2 ounce per gallon solution of sodium carbonate is used to clean the parts, cathodically, at 120° F. No acid dip is used ahead of chromium, the provision had been made for one—consequently, we have three water rinses after the cleaning. Chromium plating is for two minutes in a solution carrying, per gallon, 52 ounces of chromic acid, 0.77 ounce of sulphuric acid; ratio, chromic to sulphuric acid 67:1. In a typical analysis, the iron ran 0.20 ounce and the trivalent chromium 0.12 ounce per gallon. Current density is around 225 amperes per square foot. The usually recommended ratio of 100 to 1 does not work with us because nickel is passive, there being no acid dip before chromium plating. Plating of excellent brilliance and good coverage is obtained by this system. Defective chromium, due to whatever cause, is currently running only about 0.75%.

Determining Surface Area of Stampings

By NATHANIEL HALL

Newark, N. J.

THE accompanying charts may be used to determine the surface area of the great majority of stamped products of copper, brass and steel with an accuracy which is sufficient for all practical plating purposes and with a minimum of effort.

There are a few conditions which will affect the accuracy of these charts. If the stampings are of heavy gauge, and are either very small or have a large number of holes punched in them the areas of the cut edges should be taken into account. Also if there is an appreciable reduction in the thickness of the sheet, such as is encountered in deep drawing, the final thickness of the stock will be less than the original gauge and the surface area will be greater by an amount depending on the amount of reduction.

To determine the surface area of an ordinary stamping, a sample, or a few samples if the articles are very light, is weighed up, and if the Brown and Sharpe gauge is not known, the thickness is measured with a micrometer caliper. The point on the horizontal scale corresponding to the weight of the sample in ounces or grams is followed vertically until the curve corresponding to the stock gauge or thickness is reached. A horizontal line drawn from this point will intersect the vertical axis at a point corresponding to the area of the sample.

For example, if a brass stamping of ♯22 B. & S. stock weighs 4.6 ounces, a line is drawn vertically at this weight on Figure I, which is for sheet brass, until it hits the 22 gauge curve (see dotted lines, Fig. 1). A horizontal line drawn from this point intersects the vertical axis at 0.514 square feet. If the samples are very light, a number of pieces are weighed together, in which case the surface area will be that for the sum of the pieces.

Occasionally it will be found that a large stamping of light gauge or a heavy stamping will not fit the scale. In such cases an appropriate fraction of the weight is used with the chart.

For example, a brass stamping of ♯30 B. & S. brass weighs 4.2 oz. We find that the 4.2 oz. line in Fig. I does not intersect the ♯30 B. & S. Curve. We therefore look up the area of half this stamping which would weigh 2.1 oz. and find it to be 0.595 square feet. The whole stamping therefore has an area twice this or 1.19 square feet.

As another example, suppose a stamping of 1/16″ brass stock weighs 23 oz. Since the scale goes only to 8 oz. we would look up an area corresponding to say one-tenth the stamping or 2.3 oz. and find it to be 0.103 square feet. The area of the stamping would therefore be ten times this or 1.03 square feet.

Charts such as these are much more satisfactory than the common practice of tracing outlines of the stamping on cross-section paper and adding up the squares, especially on stampings of complicated shape. The determination requires much less time and all that is necessary is a knowledge of the thickness of the metal and a small scale which will read in ounces or in grams. A postal scale is usually sufficiently accurate for this purpose and is available almost everywhere.

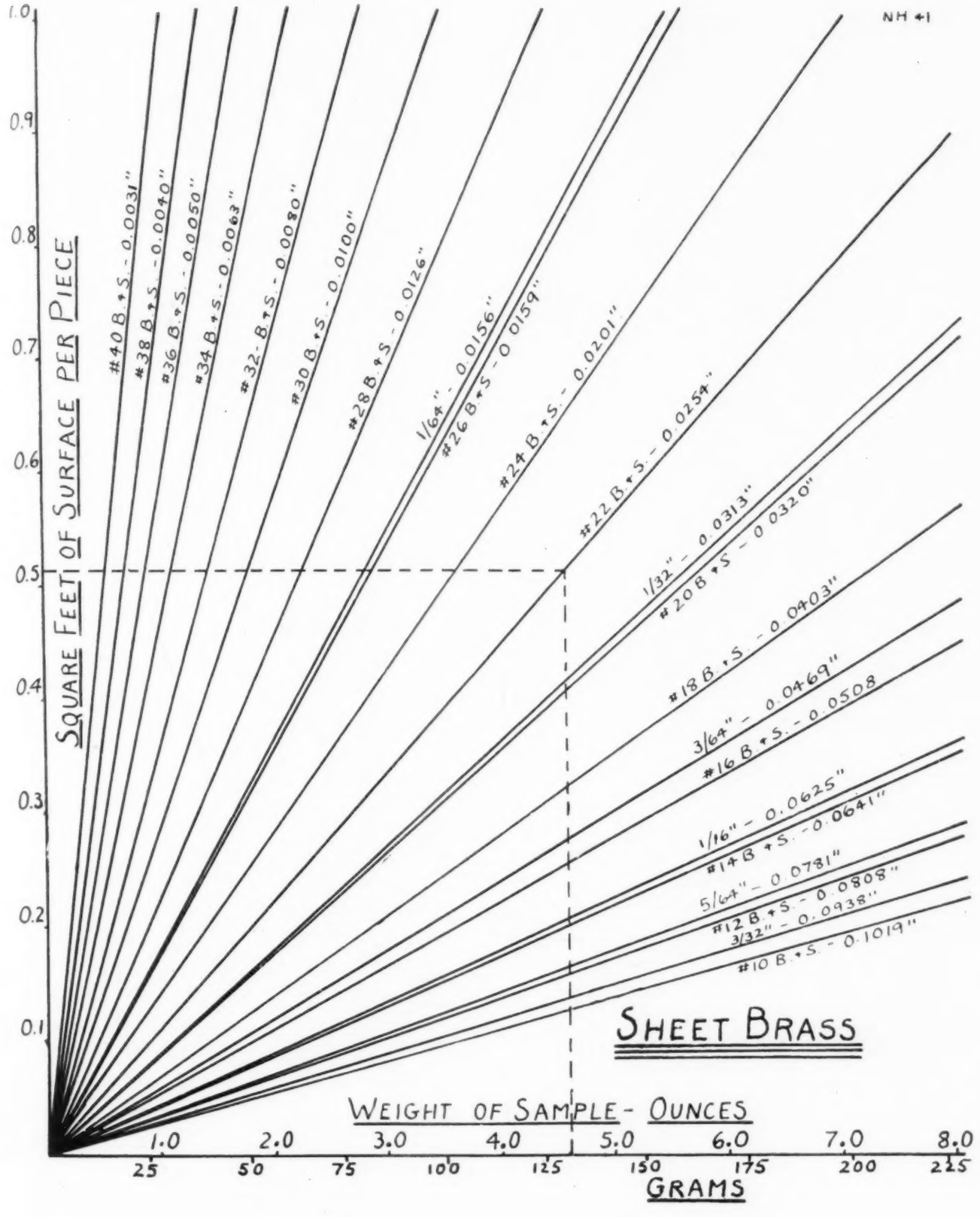


Figure 1. Chart for Determining Surface Area of Sheet Brass.

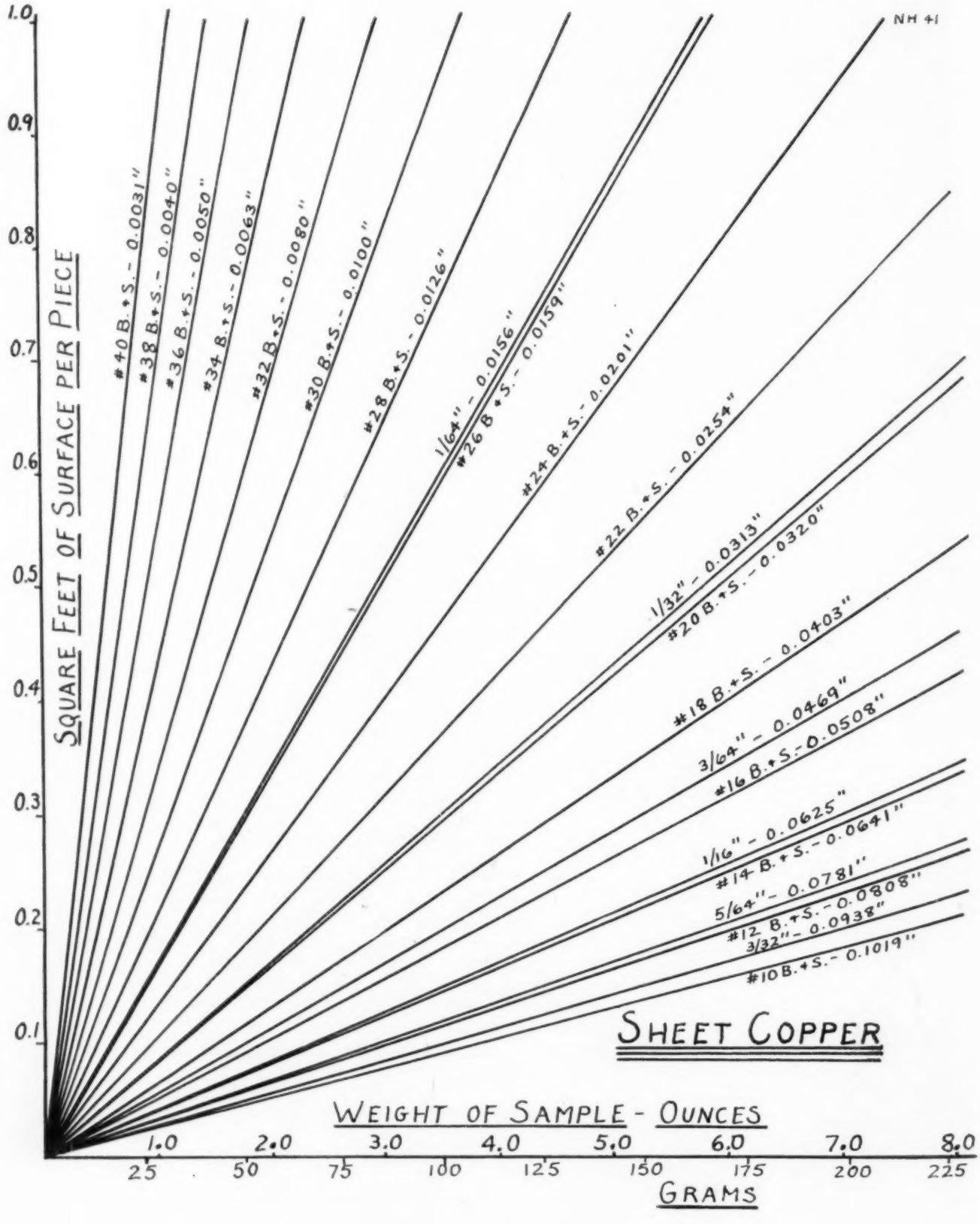


Figure 11. Chart for Determining Surface Area of Sheet Copper.

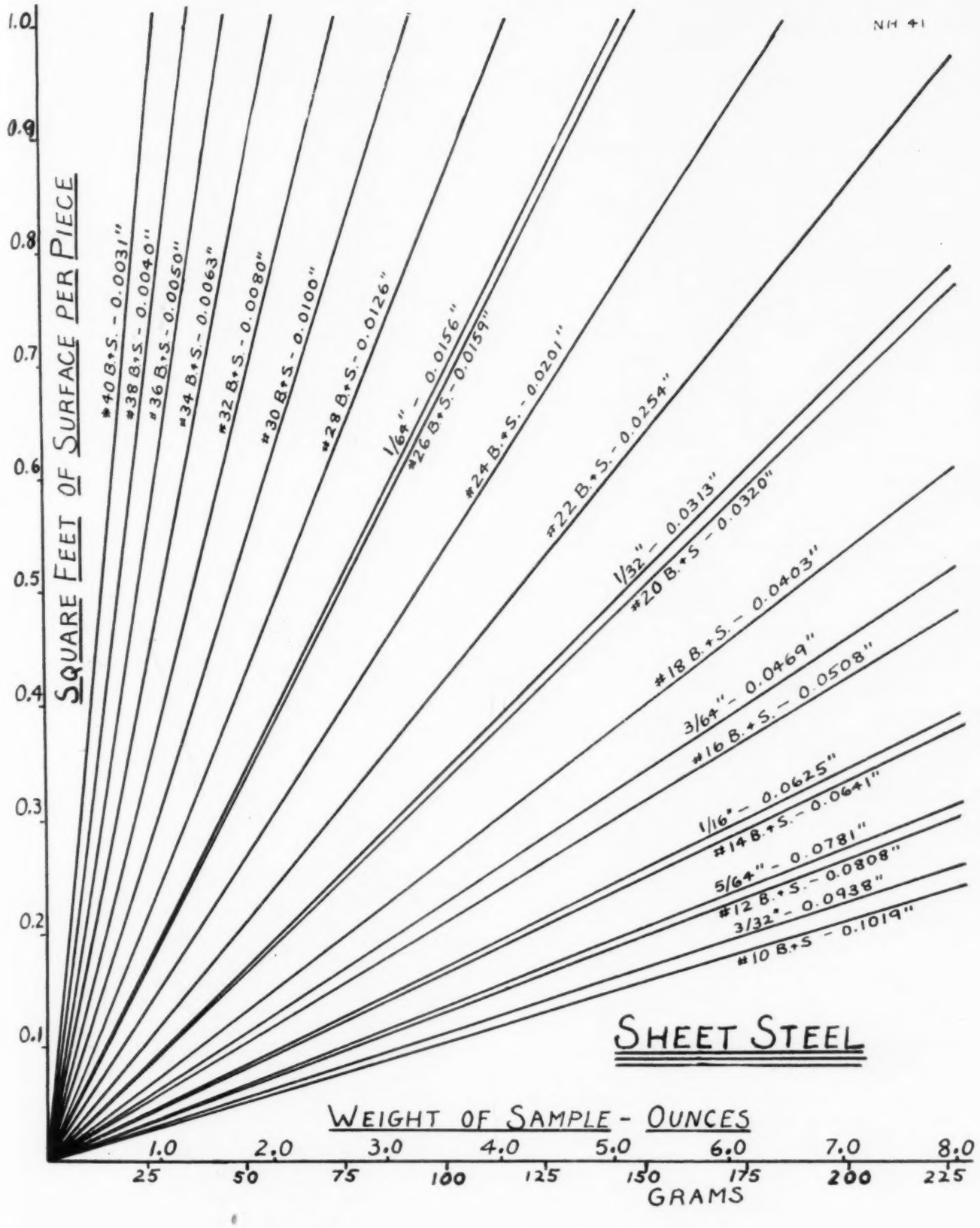


Figure III. Chart for Determining Surface Area of Sheet Steel.

Metal Coatings On Non-Conducting Materials

PART I

By Samuel Wein

New York

The author presents an extensive review of the literature on methods of metal coating non-conducting materials. The applications of metallizing are first discussed. The procedure of applying metal to non-conductors is then outlined. Cleaning and silvering methods are discussed at length and complete details for silvering methacrylate resins are given. Methods proposed for chemical deposition of copper films are reviewed.—Ed.

Introduction

THE electrolytic deposition of metals on non-conducting surfaces (insulating materials) has been in common use from an industrial and technical viewpoint for a great number of years, in fact, one industry alone has been depositing copper on wax for more than one hundred years.

There are a number of processes which are common knowledge to those identified with the art, and yet unknown to the average plater. This is because there is no justification for the average plater to be familiar with the subject matter until recently, and since conditions have materially changed the aspects of things, the average plater was obliged to familiarize himself with these various processes in order that he might best serve his local trade and community.

A general survey of these various methods is not available to the average plater, because the information is so scattered in the technical and patent literature that it would take many weeks to properly collect and corrolate it into specific processes, and so make it easy for the average plater to comprehend. The author of this text has been collecting this information for his own use, and, on the invitation of the Editor, Dr. Meyer of METAL FINISHING, I am now pleased to give this collection of information to my fellow workers.

The detailed facts given in this resume of the literature were abstracted from the original sources from which the literature in smaller type is referred to.

Because of the restrictions in certain metals for certain industries, the deposition of metals on non-conducting surfaces will solve many a headache and problem, since the finished product will not only look as if it were made entirely of metal, but in many cases combination effects, not now possible in the use of metals, can be had.

Applications

It is fitting to review here some of the uses to which industrial deposition of metals on various non-conducting surfaces have been applied, this will give one an idea of the seriousness with which the subject matter is now being considered.

Containers: For gas and liquid proofing containers.

Silver films deposited on the inner walls of plastic containers will prevent chemical action between the essential oils, cosmetics, medicaments and food stuffs, usually found in such containers.

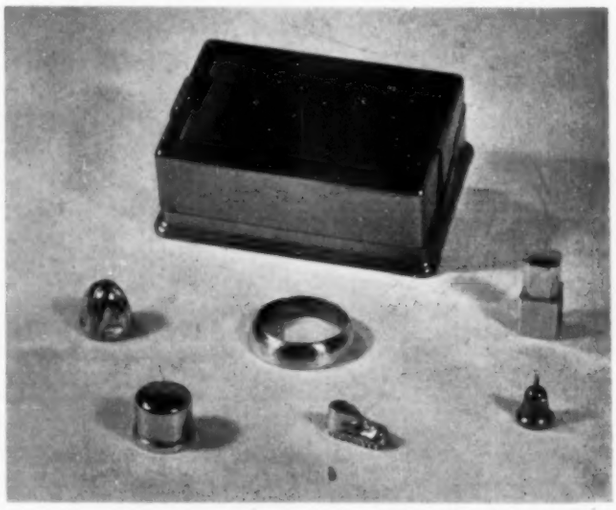
Electrical: Fuses, contacts, high tension devices, condensers, etc.

Industrial: Cams, Farxay cages, handles, instruments, machine parts, reflectors, rollers.

Mirrors: Backing up silver films in the place of asphalt paints, Heliograph mirrors. The specifications as outlined by the War Department demand the silver mirrors be copper plated in the place of asphalt paints as the "backing medium."

Electroformed metal reflectors are used in the motion picture projectors (theatres), and these are made by first having an accurate mold made in glass, precipitating a silver mirror on its surface, subsequently depositing on a sufficient thickness in copper. The reflector so formed is now released from the glass mold by placing this in hot water, then in cold, changing from one to the other, several times, and the contraction and expansion between the two is such that the electroformed metal mold will slip off with ease and without resorting to the use of sharp implements to pry it off. The silver surface is then plated with rhodium and highly polished and serves as the reflecting surface. The rhodium will not tarnish like silver.

Molds: For the plastic industry (injection compression, casting etc. molding).



Some typical plastic parts that have been metallized. (Courtesy Metaplast Corp., New York).

In the reproduction of alligator and snake skin effects, molds are made from the original by electroforming, and these molds are used in processing treated cloths to simulate the effects of the original.

Museum Objects: Bugs, mice, insects, butterflies, turtles, turtle shells, scallop shells, antlers, hoofs, etc.

Novelties: Bag frames, ash trays, bracelets, buckles, buttons, cigarette cases, cigarette lighters, combs, compacts, containers, costume jewelry, fountain pens, jar tops, mirrors, pencils, beads, poker chips, razors, imitation ivory carvings, photographic negatives, positives and transparencies, babies shoes.

Radio: Antennas, cabinets, coils, condensers, dials, grilles, knobs, shields, condensers (glass and mica).

Thermometer bulbs, chemical glass-ware and soda siphons are coated with heavy films of copper, to reinforce them and prevent them from breaking.

Transportation: Airline accessories, dashboard fittings, electrical equipment, escutcheon plates, handles, instrument parts, knobs, molded parts.

Wax and wax-like compounds (metallic stearates), glass, rubber, gutta percha and rubber substitutes, plastics, plastic wood, paper, papier mache, bituminous materials, stone, terra-cotta, mica, flowers, leather, dead animal tissue, plaster of paris, wood, etc.

According to Winkler,[1] electrotyping[2] is the largest application of electroforming and the industry is about one hundred years old, and in the United States approximately three hundred "electrotypers" produce duplicate printing plates valued at nearly $30,000,000.00 annually. Electrotypes are duplicate letter-press printing plates and find general use in the industry. High speed rotary letter-press printing is done exclusively from electrotypes.

Miscellaneous: Bottle closures, boxes, dental plates, hardware, musical instruments, plastic sheets, statues, etc., etc.

Procedure

The deposition of metals on non-conducting surfaces requires the following successive steps:

1. *Roughening.* Assuming the surface of non-conducting material is smooth, i.e., like glass, it will have to be roughened in order to facilitate the adherence of the deposited films to it.

2. *Cleaning.* The material is now cleaned from dust, dirt, oil and other foreign materials, in order to facilitate the adherenec of the deposited film.

3. *Priming Film.* A primary film is deposited on the roughened and cleaned surface of the non-conducting material. This priming film serves as the electrical conducting means on which the subsequent metals are electrodeposited.

4. *Deposition.* Usually a thin film of copper is plated onto the priming film for about 30 to 60 minutes.

5. *Finishing.* Silver, gold, chromium and other metals are now plated on top of the copper film, and otherwise finished as in the case of buffing, lacquering, etc.

Roughening: This sometimes is had in the finished product. Assuming this is not the case, it can best be done by means of a coarse pumice, sand-blasting or etching chemically. The process depends on the number of pieces to be treated and the nature of the material under consideration.

Cleaning: In order to form a homogeneous and tenacious film of metal on the insulating material, a very necessary requisite is that the surface be *clean.* If the surface is not clean, films of metal will deposit in spots and form a loose or mottled deposit on the given surface.

The kind of contaminants usually found on these surfaces are dust, chemicals, oils, finger-marks, etc. These are not difficult to remove, and in some cases only cold water is all that is necessary with the aid of a scrubbing brush. Hot water, assuming of course that the material in question will permit it, is better.

Mild "metal cleaners" will serve to better advantage in removing the oils, finger-marks and chemical films usually found in commercial products.

Tri-sodium phosphate, borax, wetting agents, carbon tetrachloride, caustic soda, Calgonite, nitric acid, have been used. Their use, of course, depends on the nature of the material to be cleaned, bearing in mind that there must be no reaction (chemical) product between the cleaning compound and the material treated with it remaining loose on the surface.

Usually, these cleaning compounds are used in diluted solutions (aqueous) and at elevated temperatures, in order to hasten the cleaning action.

Some workers merely steep the article to be cleaned in the solution, but the better way is to scrub the given surface with a more or less stiff brush.

After this has been done, the article is now washed with running cold water, exercising care at all times not to allow the fingers to touch the surface as this will once again deposit the oils from the hand, and once again the article in question will have to be recleaned.

Use Distilled Water: Ordinary tap water is unfit for the preparation of stock solutions used in the following processes. This is because the city water contains salts, which, when in contact with the salts used in the preparation of metallic films, will be immediately precipitated out of solution, and these interfere with the successful formation of metal films.

In view of the foregoing, it is well that distilled water be used in the preparation of these stock solutions. Distilled water can be had from any local drug store or automobile repair shop.

Under no circumstances should "mineral water" be used, since this contains a great percentage of dissolved solids and gases in it.

Hence, all formulas given in this text will call for distilled water, although no further reference will be had with regards to this point in the formulas about to be given.

Silvering Methods

This present method appears to be the most popular of the commercial methods commonly used for the deposition of metals on non-conducting surfaces. This popularity appears to be based on the fact that everyone appears to realize that silver films presents no difficulty in deposition of metals on it to a given surface. The other reason for this popularity of use is because the precipitation of silver films is a practical commercial procedure.

There are several common or accepted methods using reagents that will precipitate metallic films on glass surfaces, and these are: (a) Rochelle salts (sodium-potassium tartrate), (b) formaldehyde, (c) cane (invert) sugar. Of course there are other compounds in the literature that have

1. J. H. Winkler, Trans. Electrochem. Soc. Pre-print 80-28, p. 359 (1941).
2. Nat. Bur. Standard. Circ. No. 387.
   Tech. Bull. No. 19, Government Printing Office.

made good mirrors, but these are of academic interest and their review here need not be considered. For completeness sake, we give here a resume of the literature for the benefit of those who might be sufficiently interested to investigate further the other methods. They are:

Bennett, "Chemical Formulary."
Gordon & Case, Bureau of Standards Circular #389, 1931.
Hopkins, "Scientific American Formulary."
Setapen, "Silver in Industry."
Wood, Jour. Soc. Chem. Ind. *15*, p. 19, (1896).
Silverman & How, Jour. Ind. & Eng. Chem. *9*, p. 1032 (1917).
Sharp, Glass Industry, *11*, p. 273 (1930).

Herewith follows a laboratory method for forming silver films on Plexiglas as worked out by the chemical staff of Rohm & Haas, manufacturers of Plexiglas (methyl-methacrylate). This method has never been worked on a large scale, other than in a laboratory, and there is no reason why it should not work on a large or commercial scale. The formula as worked out with respect to proportions is sufficient to cover an active area of 10″ x 16″ (one side).

The Solutions

Four solutions are required for this method. These are as follows:

Solution A: For the pretreatment of the Plexiglas.

Sodium hydroxide (reagent grade) 350 grams per liter (or 2.92 pounds per gallon) of water.

This solution must be made up in and kept in a clean glass container. It may be kept and used as long as it does not become badly discolored or turbid. It is suggested that only enough of this solution be prepared to fill the pretreatment tank and that it be replaced by fresh solution or very carefully filtered through asbestos whenever it becomes turbid or yellow. Contamination of this solution by iron or iron salts must be avoided.

Solution B—The reducing solution

Cane sugar (granulated)	90 grams
Nitric acid (C.P. Reagent grade)	4 cc.
Ethyl alcohol (grain alcohol) 95%	175 "
Water (distilled) to make	1000 "

Prepare this solution in a clean glass container as follows:

Dissolve the cane sugar in 500 cc. of distilled water. Add the nitric acid slowly with stirring. Then add the alcohol and dilute with distilled water to make up the total volume to 1000 cc.

CAUTION. This solution must stand at room temperature for at least one week before it is ready for use.

Solution C—The silver solution—to be made up in three parts.

Part I	—Silver nitrate (Reagent grade)	100 grams
	Distilled water	1000 cc.
	Make up and store in a clean brown glass bottle.	
Part II	—Sodium hydroxide (Reagent grade)	100 grams
	Distilled water	1000 cc.
	Make up and store in a clean glass bottle.	
Part III	—Ammonium hydroxide (C. P. Reagent grade—28%)	400 cc.
	Distilled water	600 "
	Make up and store in a clean glass bottle.	

All silvering solutions are to be kept at room temperature (70-80° F.) and the silvering operation is to be conducted at the same temperature. "Hot table" silvering is not suitable for Plexiglas.

These solutions may be stored indefinitely at room temperature as long as the bottles are kept well stoppered and out of direct sunlight.

Solution D—For removing silver deposits from Plexiglas and other surfaces.

Nitric acid (C.P. Reagent grade)	500 cc.
Distilled water	500 "

Mix this solution by slowly adding the acid to the water while constantly stirring the mixture. Store in a clean glass bottle.

Solution E

Dreft (wetting agent)	50 grams
Distilled water	1000 cc.

Make up and store in a clean glass bottle.

The Apparatus

Pretreatment Tank. A container is required in which the Plexiglas can be treated with Solution A. This container should be arranged so that the pieces of Plexiglas can be placed in it about ½″ apart and in a vertical plane. The container should be deep enough to permit entirely immersing the pieces of Plexiglas.

This pretreatment tank *must be* made of some material which will withstand the action of the 25% Sodium Hydroxide Solution A. A tank made of pieces of Plexiglas cemented together with a special Plexiglas cement has been found very suitable for 10″ x 16″ pieces. A glass tank will also be entirely satisfactory. For the treatment of large pieces, it may be found desirable to use a nickel-clad iron tank or a heavily nickel-plated iron or copper tank.

Silvering Tray. A Plexiglas, glass, hard rubber, or enamel lined tray will be required for the silvering operation. This tray should be very nearly the same size as the pieces of Plexiglas in order to economize on the silvering solutions. It should be about one inch deep. Some method is required for holding the Plexiglas flat and in close contact with the bottom of this tray to avoid as much as possible the formation of a silver deposit on the front surface of the mirror.

It is convenient to use a tray having about a ¼″ clearance around all sides of the piece of Plexiglas. A ⅛″ thick soft rubber gasket about ½″ wide is cemented to the bottom of the tray all around the edges. This gasket is a continuous piece of rubber cut from a sheet that will just lay in the tray. Several smaller pieces of this gasket, about 1″ x 1″ in size should be cemented to the bottom tray to act as supports to the Plexiglas. The Plexiglas can be held in tight to this gasket either by hand or preferably by attaching the vacuum line from a water aspirator to a nipple in the bottom of the tray and slightly evacuating the space between the Plexiglas and the tray. This method of holding the Plexiglas greatly minimizes the deposit on the front surface and permits making a full sized mirror without clamping marks and stains in the silver deposit.

Miscellaneous. The following glass ware will be required during the silvering operation.

1. Flask or wide mouth bottle for mixing components of Solution C. Size to be determined by requirements of silvering operation. Allow approximately 600 cc. per square foot of Plexiglas.

2. Flask or wide mouth bottle large enough for one application of the silvering solutions. Allow about 200 cc. per square foot of Plexiglas.
3. A large graduate for measuring out components of Solution C and a small graduate for measuring out Solution B.
4. Large glass container into which the spent silvering solutions may be poured and salted out.

A pair of good rubber gloves.

A supply of clean running water is required. A smaller supply of distilled water is also very desirable.

A suitable rack is required for supporting the mirrors during the drying process. This rack should be covered at the top to protect the mirrors from the dust depositing from the air but should open enough at the sides to permit a free drying of the mirror.

A paint is required, preferably pigmented with aluminum powder or a light grey pigment, the vehicle or resin of which is not a solvent for Plexiglas. This paint is used to protect the back of the mirror from mechanical abrasion and the action of corrosive atmospheric gases.

We recommend spraying the protective paint on the backs of the mirrors to avoid scratching. In case spraying equipment is not available, the paint should be flowed on with a high grade soft hair brush.

The Silvering Operations

A. Wash the rubber gloves carefully with soap and water to remove all traces of dirt and grease. These clean rubber gloves must be worn throughout the entire silvering operation, both to protect the hands and to protect the surface of the Plexiglas.

B. Fill the pretreatment tank with enough of Solution A to entirely immerse the pieces of Plexiglas which are to be silvered.

C. Carefully place the pieces of Plexiglas, in the pretreatment tank. Carefully examine the pieces after they are placed in the tank to make sure that no air bubbles have been trapped in contact with the surface of the Plexiglas. Force the Plexiglas to remain below the surface of the solution by weighting down with a heavy piece of clean glass or a clean bottle filled with sand. These pieces are to be left in this solution for 24 hours.

CAUTION. Do not touch the surface of the Plexiglas except when it is absolutely necessary. Never lay the Plexiglas down with its surface in contact with anything except clean tissue paper. When the Plexiglas must be handled it should always be set on edge and leaned against a clean vertical surface. When the Plexiglas is placed in the silvering tray, it must not be moved about.

Extreme importance must be attached to the careful handling of the Plexiglas to avoid scratching the surfaces. Since Plexiglas is so highly transparent, minute scratches will show up quite plainly after silvering.

After the Plexiglas has been immersed in Solution A for 24 hours, proceed with the following operations.

D. Determine approximately the amount of liquid required to cover the pieces in the silvering tray to a depth of ¼".

E. Prepare three times this amount of Solution C, for each piece of work to be silvered, by adding 50 parts of II and 40 parts of III to 1250 parts of distilled water. To this mixture slowly add, with constant stirring, Solution I (Approximately 150 parts of I will be required). It is desired to obtain in the end a clear solution containing a very small amount of light brown precipitate. If a permanent black precipitate is formed it is best to start over again with fresh solutions. If a permanent light brown precipitate is formed before 150 parts of I have been added, add an additional 1 or 2 parts of III and proceed with the addition of I until at least 150 parts (and not more than 170 parts) of I have been added and a clear solution with a very small amount of light brown precipitate is obtained.

CAUTION. This mixture must not be kept from one day to the next.

F. Measure out the quantity of this solution (C) required for one application. For each 20 cc. of Solution C, 1 cc. of Solution B is required. Measure out the proper amount of B for one application.

G. Take a piece of Plexiglas out of the pretreatment tank (always using rubber gloves). Rinse thoroughly under clean running tap water. Follow this by a single rinse of distilled water and place carefully in the silvering tray. Secure piece in tray by one of the methods previously outlined. Rinse again with distilled water. Always keep an unbroken film of water or silvering solution on the surface of this piece which is to be silvered.

H. Immediately mix the proportions of Solutions B and C as measured out in F and pour this over the work in the silvering tray.

I. Rock the silvering tray so that the solution travels all the way across the piece of Plexiglas. Continue this rocking, as the deposition of silver progresses, until the solution has become colorless and the flocculent grey silver precipitate has coagulated. Immediately pour this spent solution off into a container reserved for this purpose, in which has been placed 100 cc. of Solution D per 1500 cc. of Solution C. Rinse off, into this container, the remaining precipitate with distilled water. (See method of silver recovery). Rinse off the mirror under rapidly running (not a jet) tap water to dislodge and remove small particles of precipitate. Rinse again with distilled water (this and other rinses of the mirror with distilled water, while in the silvering tray, can conveniently be done with a chemist's wash bottle).

J. Immediately pour over the mirror a second mixture of Solutions B and C measured out according to F. Proceed as before in H and I, except that before the final rinse of distilled water the mirror should be carefully swabbed with a bit of clean cotton while rinsing with the tap water. Rinse again with distilled water.

K. Immediately pour over the mirror a third portion of the solution prepared according to F. Proceed again as in H and I.

L. Remove the mirror from the tray and rinse both sides of the mirror under running tap water for 2 or 3 minutes. Follow this with a rinse of distilled water being careful to prevent any tap water from again coming in contact with either side of the mirror.

M. Place the mirror on edge in a rack to dry. The mirrors should dry at room temperature (or a temperature not exceeding 35° C.) for 48 hours. *Do not touch the silvered surface.*

N. Apply the protective paint to the back of the mirror, being careful to keep this paint off the front surface of the mirror. Allow this paint to dry.

O. The silver deposit (if any) on the front surface of the mirror may now be removed by a very careful application of

Solution D. Apply this solution in sufficient quantity to rapidly remove the silver and immediately flush off with tap water.

CAUTION. Do not let this solution come in contact with the back of the mirror.

P. Using a cotton swab, carefully sponge the front surface of the mirror with a bit of Solution E. Rinse both front and back thoroughly with running tap water and then with distilled water.

Q. Place in rack to dry. If the mirror is to be trimmed or cut, this may be done before the silver is removed from the front surface, thus saving a washing operation.

If these operations have been carefully followed, a good Plexiglas mirror will be obtained. The color and adhesion should be good. If spots or streaks appear they are probably due to lack of cleanliness before the first coat of silver is applied. If pinholes are found in the silver deposit, these are probably due to failure to rock the silvering tray sufficiently to prevent the precipitate from sticking, or to insufficient swabbing and rinsing after the application of the second coat. At the same time too much swabbing will produce thin spots in the final silver deposit. Finger print marks are probably due to touching the Plexiglas or the silvered surface at any time before the protective paint is applied.

After completion, the mirrors should be wrapped in clean tissue paper.

In conclusion the essential points of this process should be again outlined.

I. *Keep the surfaces of the Plexiglas clean.*
II. Keep the rubber gloves free of all greases and dirt.
III. Use a clean treatment solution (A) to properly prepare the surface for reception of the silver deposit.
IV. Use clean silvering solutions and clean water during the silvering operation.
V. Mix the silver Solution C with care.
VI. Do not allow the surface of the Plexiglas on which mirror is to be deposited, to become dry from the time of immersion in the pretreatment bath until after the third coat of silver has been applied.
VII. Do not allow droplets of tap water to dry on the surface of the Plexiglas—always rinse with distilled water and allow to dry by evaporation. Do not attempt to wipe dry.
VIII. Do not lay the Plexiglas or mirror down on its surface except in the silvering tray or on a clean piece of tissue paper.
IX. Avoid touching the silvered surface with the bare hands. Finger marks will produce stains which will become larger and more prominent in time.
X. If the protective paint is to be applied with a brush, extreme care must be taken to prevent the bristles or grit particles from scratching the silver deposit. Flow the paint on gently but avoid using too much paint as too thick a layer may impair the silver deposit. If greater protection is desired, apply several thin coats.

Silver Recovery

Since this silvering process is not very economical, it may be desirable to recover the surplus silver. This may be done by applying a chloride recovery process directly to the contents of the residue container of Part I.

It is preferable to add Lykopon (Rohm & Haas Co.) to the residue container of Part I in place of the nitric acid. This precipitates all of the silver that remains in the solution a flocculent precipitate. Since the precipitate originally in the spent solution is also pure silver, it is only necessary to wash (by decantation) this precipitate free of all soluble salts. The residue may then be taken up with nitric acid and pure silver nitrate crystallized from the resulting solution.

Filtering Solution A

If upon standing and use this solution of sodium hydroxide becomes turbid, it may be desired to filter rather than discard it. This may be done by filtering through an asbestos filter mat in a Buchner funnel. The asbestos fibre may be obtained in a purified form from any chemical ware supply house. Make a thick suspension of this fibre in distilled water. Pour some of this suspension on the Buchner funnel, distribute evenly, and allow the water to drain off slowly. Attach the funnel to a filter flask and turn on the vacuum. If the asbestos has been properly applied, a thin hard mat of uniform thickness will be formed. If this mat has holes in it, another thin layer of asbestos must be applied at these spots. Wash this mat with distilled water several times to remove the very fine fibres. The mat is now ready for filtering.

Do not pour the hydroxide solution directly on the filter mat. Place a small beaker in the middle of the mat and slowly pour the solution into the beaker until it gently overflows and runs down on the mat.

This filtering operation should be repeated until a crystal clean and nearly colorless solution is obtained. If such cannot be obtained, it is recommended that the solution be discarded and a new one carefully prepared.

Miscellaneous Literature References

OW-ESCHINGEN

The plastic (phenol-aldehyde type) material according to Ow-Eschingen[3] is treated with a compound consisting of:

Hydroquinone	4 parts
Pyrocatechin	1 part
Acetone	100 parts

from 3 to 5 minutes, is well dried, and then placed in a 2 per cent solution of silver nitrate heated to about 80° C. A firmly adhering film of metallic silver will be found on the surface of the plastic.

In the case of urea types of plastics, a 4 to 5 per cent solution of hydroquinone heated to about 90° C. for about 2 minutes. The plastic material is dried and then immersed for 1 to 2 minutes in a 2 per cent solution of silver nitrate at 80 to 90° C.

FREUND

Freund[4] first treats the plastic compound with

Sulphuric acid, 66° Bé	100 cc.
or	
Potassium dichromate	15 g.
Water	25 cc.

The plastic compound is then washed with running cold water and is silvered with:

Solution No. 1

Silver nitrate	4 g.
Water	100 cc.

3. Ow-Eschingen, U. S. Patent 2,010,805, Aug. 13, 1935.
4. Freund, U. S. Patent 2,063,034, Dec. 8, 1936.

Solution No. 2

Ammonium hydroxide (sp. gr. 0.88)	8.3	cc.
Water	100	cc.

Solution No. 3

Potassium hydroxide	4	g.
Water	100	cc.

Solution No. 4

Rock candy	3.5	g.
Alcohol (Alcorub)	12	cc.
Nitric acid (sp. gr. 1.42)	10	drops
Water	200	cc.

In preparing solution No. 4, it should be boiled for approximately 10 minutes, cooled, filtered and diluted with water to replace one half of the solution loss caused by boiling. An additional 10 drops of nitric acid is added.

In use, equal volumes of the four solutions are thoroughly mixed and the resulting solution at once poured over the given surface.

PEACOCK

Peacock[5] deposits the film of silver by means of an air gun in the same fashion one does lacquers, at the Libby Owens Ford Glass Co., in Toledo, Ohio. Here the silver solution in one glass container and the reducing solution in another container, both are simultaneously forced in the proper proportion by means of the lever controlled by the operator. Mechanical means are described for heating and feeding the glass plates in the heating chamber and so mechanically forming the mirror in every step from the very start to the finish.

WALKER

Walker[6] cleans the surface of the plastic with gasoline, thereafter washed in running water, and subsequently treated with a solution of stannous chloride and then the silvering process is carried out. This is the basis of the Metaplast process.

SPECIAL CHEMICALS CORP.

The "Metalon process" is the development of L. Cinamon of the Special Chemicals Corp., 30 Irving Place, New York, consisting of three different solutions, separately sold, and these are:

No. 102 A conc. "sensitizing solution".
No. 103 A conc. "conducting solution".
No. 104 A conc. "metalizing solution".

G. B. HOGABOOM, JR.

Hogaboom[7] suggests immersing Bakelite in the following solution:

Silver oxide	1	oz.
Ammonia	155	cc.
Water	1	gal.

The object is allowed to dry for about 3 to 4 hours, and the surplus silver oxide removed with a fine camel's hair brush, and it is then placed in an acid copper sulphate solution. It is claimed that the formaldehyde in the synthetic resin (Bakelite) will reduce the silver oxide and hence no reducing agent is needed as in the case when glass or similar materials are used containing no formaldehyde.

Plating of flowers, insects and other tissue is difficult because of the nature of the material being handled. With the more delicate objects, it is well to give them greater mechanical rigidity, and this can best be done by applying several thin films of shellac. When the solvent (alcohol) has completely evaporated, the object is then placed in a strong solution of silver nitrate, subsequently transferred to a box hermetically sealed and into which is passed a steady flow of hydrogen sulphide, forming a film of silver sulphide on the surface of the object, and onto this can be electrolytically deposited copper, silver, gold, etc.

In the case of animal tissue, like the larger bugs, frogs, etc., it is first placed in a solution of:

Mercury bichloride	½	oz.
Water	1	qt.

which destroys the odor and prevents further decay of that object. This is then allowed to dry for at least 24 hours, and subsequently treated as in the above case prior to treatment for plating.

Copper Films

Copper films, like silver can be deposited on glass, ceramics, plastics, etc. Just as in the case of silvering methods, films of copper are formed by reducing with formaldehyde, hydrazine, etc. Herewith follows several of these methods.

A fresh mixture[8] of 454 parts of a metal solution and 100 parts of a reducing solution is used. The metal solution consists of 100 parts copper chloride (1:5), 2 parts platinum chloride (1:10), 2 parts zinc chloride (1:5), 50 parts ammonium nitrate (3:100), 10 parts Rochelle salts (1:2), 200 parts ammonium hydroxide (1:10), all dissolved in water in the proportions indicated in parentheses. The solution must have an alkaline reaction. The reducing solution consists of 2 parts cane sugar (1:20), 1 part glycerol (1:10) and 1 part formaldehyde. The platinum chloride may be partially or entirely replaced by gold chloride. The reduction rarely goes beyond copper oxide if the zinc chloride is omitted.

WEISKOPF

As far as can be ascertained, it was Dr. Weiskopf[9] of Morchenter, Bohemia, who gave the first formula for depositing films of copper on glass by precipitation. This process remains the basis of the processes most widely used today. He employed formaldehyde as the reducing agent, and the process was made up of:

			Parts
(A)	Sol. No. 1	Copper chloride solution in water at the ratio of 1:5	100
	Sol. No. 2	Platinum chloride solution (or gold) in water, in the ratio of 1:10	2
	Sol. No. 3	Zinc chloride solution in the ratio of 1:5	2
	Sol. No. 4	Ammonium nitrate solution in the ratio of 3:100	50
	Sol. No. 5	Rochelle salts, in the ratio of 1:10	100

5. Wm. Peacock, Jr., Ind. & Eng. Chem. **14**, 274 (1938).
6. Walker, U. S. Patent 2,214,646, Sept. 10, 1940.
7. G. B. Hogaboom, Jr., "Plating and Finishing Guidebook," 1941 Edition, p. 79.
8. Diamant. **32**, 41 (1910). Chem. Abstracts **4**, 955 (1910).
9. Weiskopf, Ger. Pat. 124,710.

Sol. No. 6	Sodium hydroxide solution in the ratio of 1:10	200
(B) Sol. No. 1	Cane sugar solution in the ratio of 1:20	2
Sol. No. 2	Glycerine, in the ratio of 1:10	1
Sol. No. 3	Formaldehyde (40%)	1

Mix 454 parts of solution "A" to 1 part of solution "B". Of the metal chlorides used, gold was found to give the best results.

For practical purposes on a large scale, the original formula had to be varied and simplified, and a modernized version of the foregoing formula consists of:

Sol. No. 1	Copper bichloride	215 g.
	Zinc chloride	10 "
	Gold chloride	4 "
To be dissolved in		
	Water	1,750 cc.
Sol. No. 2	Rochelle salts	735 g.
	Water	1,650 cc.
Sol. No. 3	Sodium hydroxide	355 g.
	Lump sugar	380 "
	Glycerine	325 cc.
	Water	1,215 "
Sol. No. 4	Ammonium nitrate	9 g.
	Formaldehyde, 40%	2,100 cc.

Use 2 parts distilled water with 1 part of each of the four solutions.

The surface to be coated is first cleaned and then washed with a solution of tin chloride, and again washed with distilled water; and now the prepared copper compound is poured onto the surface. The copper will settle down as a hard layer or film of metallic copper of a cherry red color. Often one coat is not enough, and a second has to be applied. The room temperature should be in the neighborhood of 86° F. (30° C.). The film of copper will form in about 20 to 30 minutes.

BAMBERGER AND SCHWEITZER

Substituting hydrazine sulphate for phenyl hydrazine simplifies the procedure and makes it more reliable according to Bamberger and Schweitzer[10], using the following dilute solutions:

Sol. No. 1	Copper sulphate	50 g.
	Conc. ammonia	100 cc.
	Dissolved in water	1,000 "
Sol. No. 2	Hydrazine sulphate	19 g.
	Dissolved in water	1,000 cc.
Sol. No. 3	Caustic soda	20 g.
	Dissolved in water	1,000 cc.
To form the copper film use:		
Sol. No. 1		1 part
Sol. No. 2		2 parts
Sol. No. 3		1 part

The surface on to which the film of copper is to be formed is first warmed to 70-100° C. in order to accelerate the formation of the copper film.

10. K. Bamberger and R. Schweitzer, Ger. Pat. 420,469.

P. MISCATELLI

A simplified process is to first deposit a thin film of silver (mirror) onto the given surface, and then:

Sol. No. 1	Copper sulphate	4 g.
	Rochelle salts	15 "
	Sodium hydroxide	9 "
	Water	1,000 cc.
Sol. No. 2	Formaldehyde, 40%	200 cc.

To form the copper film, add solution 2 to solution 1.

PEACOCK

Silver nitrate is dissolved in an aqueous solution of ammonia[11]. An aqueous solution of copper sulphate and additional silver nitrate are dissolved in an aqueous solution of Rochelle salts. Tartaric acid is dissolved in water. The resulting solutions are added, in the order mentioned, to a further quantity of water, and the solution thus formed is poured on the glass surface to be coated, with the silver-copper film the resulting product.

Peacock[12] uses four solutions as follows:

Sol. No. 1	Add silver nitrate	16 oz.
	To ammonia, 26°	11 "

and, after solution is completed, 16 oz. of water are added, cooled, filtered, and to this are added 144 ounces of water.

Sol. No. 2	Copper sulphate	16 oz.
	Water	64 "

this solution is filtered and placed in a dark bottle.

Sol. No. 3	Water	64 oz.
	Rochelle salts	32 "

this is boiled, and to it is added 1 oz. silver nitrate dissolved in 4 oz. of water.

To this mixture at the boiling point add 4 oz. of Solution No. 2 and boil for at least 10 minutes; then cool, filter and place in a dark bottle.

Sol. No. 4	Tartaric acid	16 oz.
	Water	48 "
Let stand for one week and filter.		
Prepare the final solution from		
Solution No. 1		2 oz.
Solution No. 3		2 "
Solution No. 4		3 drams
Water		64 oz.

The film of copper may be repeated, one on top of the other.

NOTO AND UNO

Noto and Uno[13] reduce Fehling's solution by a 3.5 to 7 per cent formaldehyde solution in the presence of a very small amount of a silver salt.

The Fehling's solution is made up of:	
Copper sulphate	2 g.
Rochelle salts	4 "
Potassium hydroxide	4 "
Water	100 cc.

Copper sulphate/silver nitrate <10 is preferable.

We now come to the use of organic reducers i.e., phenyl hydrazine, to be used with copper salts.

11. Wm. Peacock, U. S. Patent 1,935,520, Nov. 14, 1934.
12. Peacock, Can. Patent 348,131, Feb. 12, 1935.
13. Noto and Uno, J. Electrochem. Assoc. Japan **2**, 375 (1934).

(To be continued in Jan. issue.)

PLATING AND FINISHING
POLISHING — BUFFING
CLEANING — PICKLING
HOT DIP FINISHES

SHOP PROBLEMS

Flat Polishing (Lapping) of Gold Alloys

Q. We would like to get information concerning the flat polishing of gold, specifically eight carat (8K) gold, on a lead tin lap, using a fine abrasive in order to produce a scratch-free finish. Does temperature and humidity have any effect on this kind of polishing? What is the composition of the lap? What kind of abrasive is used?

A. The temperature and humidity will affect the lapping operation because of the change in consistency of the lapping compounds.

There are a large number of alloys used containing lead, tin, zinc, antimony, etc. A common lead-tin lap will contain about 90% lead and 10% tin. It may also contain a few per cent of antimony for hardening. Another type of lap contains 16 parts of tin to 1 part of zinc.

The lapping compound is a fine grade of hard rouge. For mirror lapping, the finish is usually produced in two operations, first a rough cut and then a final glossing. For the first cut, a fine powdered abrasive such as tripoli or aluminum oxide powder is applied with a small amount of oil. This is usually rubbed over the lap with the thumb and worked in with a piece of hard wood or a pebble.

The final lapping is done on another lap using rouge stick with a very hard binder. There are a number of proprietary rouges, formerly imported from Europe, on the market at a high price, some containing powdered garnet.

Incidentally articles made of 8 carat gold cannot carry a quality mark since the requirement calls for at least 10 carat fineness. See Commercial Standard CS67-38.
—G.B.H.,Jr.

Drying Copper Plated Work

Q. We have a problem in connection with copper plating on which we would like to seek your advice.

At the present time we are barrel copper plating small steel parts, such as screws and bolts, in a regular cyanide copper plating bath, some to a thickness of 0.00015″ for appearance only, others to a thickness of 0.0005″ for carburizing. After plating the parts are given a cold and hot water rinse, then dried with sawdust in a wooden tumbling barrel.

Because of the fact that our tumbling barrel is not conveniently situated with regard to the copper plating unit, we would like to eliminate the sawdust drying and substitute in its place drying in a centrifuge. However, when the work is dried in the centrifuge the parts discolor and stain up within 24 hours.

We will appreciate any suggestions you have to offer which might help us in eliminating the stains which we are encountering.

A. It is possible that the final rinse before drying is not clean water. Sawdust drying overcomes the bad effects of dirty water in the last rinse, because the sawdust absorbs, or "blots off" the water, and any solids it contains in solution.

In the case of drying by centrifuge, some of the drying effect is by evaporation, and any solids in the water are left deposited on the work. The deposit is slight and invisible, but enough to cause discoloration after the work stands a while. Is the centrifugal dryer of the type using a hot air blast to aid in the drying? If so, the above reasoning applies because of increased evaporation effect. Furthermore, the air itself may be oily or dirty. Filters are available for removing dirt and oil from large volume air lines.

Suggest you try centrifuging the work after a clean, cold water rinse (not hot water). The centrifugal action will throw off most of the water before it has had the apportunity to dry on the work. After all possible water has been removed mechanically in this way, turn on the hot blast.

The following can also be tried: Dip work in hot "neutral" soap solution (2oz./gal. soap). Then go directly in to cold rinse, and centrifuge. The slight soap film left on the work will cause water to be facilitated in being thrown off. Also, the slight soap film will aid in retarding staining.
—G.B.H.,Jr.

Technical Advisor For December Issue

G. B. HOGABOOM, Jr.
Consultant in Electroplating and Metal Finishing.
Newark, N. J.

Rough and Stained Copper Plate

Q. Under separate cover we are mailing you a sample of copper cyanide solution.

We will ask you to kindly analyze this and advise us how to correct the solution. We find that the work comes out pitted and rough, and that when heavy copper plated it turns black when exposed to the air.

Will you kindly advise us how to correct this?

A. The copper and free cyanide content of your solution have been tested and are as follows:

Copper	5.6 oz./gal.
Free sodium cyanide	0.76 " "

For a straight cyanide copper solution, the metal is too high, and the free cyanide too low. There is also evidence of metallic contamination being present in the solution. This latter condition can cause the discoloration of the deposit referred to.

Other factors which cause the copper to discolor in the air are the use of excessive brighteners such as hypo or lead, and also the presence of a high chloride content. If chlorides have been used in the solution the copper deposit will have a slight film of copper chloride on its surface, and this material is light sensitive, like silver chloride, although to a lesser degree. This point can be checked as to its application in your case by placing a copper plated article in the sun and covering a portion of the surface with a mask or stencil. After a few hours exposure to the sun, remove the stencil to note if the copper beneath is lighter colored than the exposed surface.

Under normal conditions, a cyanide copper solution is run with about 2 oz./gal. of metal and 1¼ oz./gal. of free cyanide. To obtain this. remove the top clear ⅝ of the solution and place in clean steel drums. Take out and store or dump the lower portion of the solution. Replace the clean ⅜ portion, and fill the tank with water. The solution will now have about 2 oz./gal. of metal. The chlorides and contamination will also have been diluted. An addition of 1 oz./gal. of sodium cyanide is now made and this will bring the free cyanide up to 1¼ oz./gal.—G.B.H.,Jr.

Rock Island Black Nickel Plating (?) Solution

Q. The following formula is offered by the United States Army as a satisfactory means of obtaining bronze finish on small metal articles:

A. Dissolve 5 pounds of nickel ammonium sulphate in the smallest possible quantity of water.

B. Dissolve 6 ounces of zinc sulphate in one (1) gallon of hot water; add solution B to solution A very slowly and carefully, pouring from a cup with constant stirring.

C. Mix thoroughly 4 pounds of pulverized ammonium carbonate with 8 ounces of powdered white arsenic and 8 ounces of sodium hydroxide; dissolve in 3 gallons of

hot water; add solution C to solution A B.

D. Add 34 ounces of sodium cyanide to solution A B C.

E. Add hot water to make 12 gallons of solution A B C D. The material, treated with the above solution, then is lacquered.

Can you advise us whether this solution is to be used as an electroplating or an immersion, and if electroplating, would it be for barrel plating or still plating?

Perhaps there is another formula which you can recommend for barrel plating or immersion, which would be more satisfactory than the above.

A. The formula given in your letter is one that came out of the Rock Island Arsenal during the last war where it may have given good results under some set of conditions but has since been tried by several parties and has proven unsatisfactory.

The understanding has been that the formula was for electrodeposition, not immersion. Suggest you write to the U. S. Army Specification Board, Washington, D. C. for details.

A black nickel solution is recommended consisting of:

Double nickel salts	8 oz.
Zinc sulfate	1 "
Sodium thiocyanate	2 "
Water to make	1 gal.

It will give a deep brown that is suitable for small parts when barrel plated. Other conditions for operation of this solution to obtain varying degrees of color can be found on pages 52-54 of the 1941 edition of the Plating & Finishing Guidebook.

—G.B.H.,Jr.

Poor Working Silver Solution

Q. Under separate cover we are mailing to you a sample of silver solution and a piece of silver anode, with which we are having trouble. The latter, as you will see, turned black in the plating making the silver crystallize on the work. Kindly analyze sample solution and give us your report in correcting the trouble. This is a general work solution.

A. The analysis of your solution showed:

Silver	0.97 tr. oz./gal.
Free sodium cyanide	8.1 " "

The metal is low, and the free cyanide is high. The advisability of bringing the metal up to 2 or 3 oz./gal. which would be the preferable amount, would depend on whether the old solution is worth saving. It often is better to recover the silver from an old solution, and make a new one.

The old solution is not worth saving if it is badly contaminated with foreign metals such as copper, zinc, lead and iron, and if the carbonates are high. The analytical determination of metallic impurities could be made or their effect could be more readily determined for practical purposes by making a plating test.

If you add 1.5 oz./gal. of silver cyanide, the metal content will be brought up to about 2 oz./gal. The silver cyanide addition will reduce the free cyanide to 7.5 oz./gal., which is still on the high side, so avoid further cyanide additions.

The darkening of the anodes can come from too high an anode current density, or may be due to the formation of finely divided silver on the surface of the anode, which indicates poor anode corrosion, probably due to high carbonates. The first effect can be relieved by using more silver anodes in the tank.

Does your solution contain chlorides? If so, iron contamination of the solution is invited. Also, chloride solutions give more granular deposits than solutions made from silver cyanide and potassium or sodium cyanide.

Formula of Nickel Salts

Q. The writer has noticed some confusion in the formulas given for single nickel salts. I would like to know the correct formula and the nickel content of the salts for use in correcting nickel plating solutions.

A. Blum and Hogaboom in "Principles of Electroplating and Electroforming", use the formula containing 7 molecules of water ($NiSO_4 \cdot 7H_2O$) although in a footnote they state that commercial nickel sulfate usually contains both this salt and the one containing 6 molecules of water ($NiSO_4 \cdot 6H_2O$). The Condensed Chemical Dictionary and 23rd edition of the Handbook of Chemistry and Physics list both forms. Promisel in the 1941 edition of "Plating & Finishing Guidebook," gives the $7H_2O$ salt.

We have checked the composition of C.P. nickel sulfate both by precipitation with dimethylglyoxime and by electrolysis. Samples were weighed out on the analytical balance, dissolved in distilled water and diluted to a known volume in a volumetric flask. Aliquots were then taken for nickel determinations.

For the dimethylglyoxime determination, a sample containing 0.5200 gram of nickel sulfate was taken and showed a nickel content of 0.1156 gram. This is compared with the theoretical nickel content of the $6H_2O$ salt which is 0.1161 or 22.3% metal. On the basis of the $7H_2O$ salt, the nickel content would have been 0.1086 gram of 20.9% metal.

For the electrolytic determination, a sample containing 1.071 grams of nickel sulfate was taken and showed a nickel content of 0.2271 gram including the very small amount of cobalt which is present in the salt. The theoretical nickel content of the sample on the basis of the $6H_2O$ salt is 0.2272 gram.

These determinations would indicate that the C.P. salt has the formula $NiSO_4 \cdot 6H_2O$. A small difference is to be expected between the dimethylglyoxime results and the electrolytic results due to the fact that the former method determines only nickel while the latter determines cobalt and possibly some other metals which are present in minute quantities in the salts together with nickel.

On the basis of these figures and the fact that Federal Specifications for single nickel salts (O-S-61) call for a minimum of 21.4% nickel plus cobalt, while large suppliers specify a minimum of 21.6%, it is obvious that calculations on the basis of the $7H_2O$ salt containing a theoretical metal content of 20.9% would not be correct. It is suggested that nickel salt additions be figured on the basis of 22% metal.—G.B.H.,Jr.

Peeling Nickel

Q. About a year ago we encountered some trouble with our nickel solution and we are still trying to figure out just what is wrong.

It seems that, regardless of how clean our work may be, some of it will peel when plated in this particular tank, but will be O. K. when plated in another tank. This seems to show our routine prior to plating is O.K. and our solution analysis good in regards to metal impurities.

I have filtered this solution through activated carbon and clay several times and dummied at low current. While doing this it seemed to help the solution for a few days, and after that we would have the same trouble. If it is oil in the solution it must contain a wetting agent as it does not float on the solution. Could it be possible that there is some organic matter in the solution that a clay or carbon will not remove? The nickel also has a tendency to be brittle.

I am forwarding to you under separate cover a sample of work that peeled, a sample of our solution, and also a sample of cutting oil we used on some of our work. This oil is mixed with water and is used as a cutting oil.

A. The analysis of the solution shows:

Nickel	3.2 oz./gal.
Chloride, as ammonium chloride	1.4 " "
Boric acid	4.4 " "
pH	5.9

The chloride could be brought up to 3 oz./gal. for better conductivity, and anode corrosion.

The analysis of the above ingredients does not indicate that they are the cause of the peeling. If filtering the solution, and dummying at low current density improve the operation for a few days, but then peeling comes back, it would appear as though you have some source of contamination. Has the bottom of the tank been cleaned out? Also check to see if any foreign metals, such as copper anode hooks, lead lining or lead heating coil, are in circuit and slowly dissolving to contaminate the solution.

Plating hollow work can also cause contamination, as the portions which do not cover with deposit will be attacked by the solution, causing foreign metal to be introduced in the solution. Some relief can be had from this by racking the work in the manner best suited to obtain complete coverage.

It is also very possible, as you have reason to suspect, that the cutting oil is the source of your trouble. If present in the solution as a colloidal material it would be difficult to remove. Treatment of the solution with activated carbon is the remedy, but this should be done by treating the solution in a separate tank, and stirring in the carbon and allowing to stand. Running the solution through a filter containing the carbon is not so effective.

Sulfur containing cutting oils sometimes leave residues that can be removed by pickling in hydrochloric acid. Get in touch with cleaner supply houses.

Fundamentals of Science Relating to Electroplating

Chapter XIII Polarization

In a previous chapter the subject of electrode potentials was discussed and it was pointed out that when a metal was dipped into a solution containing its ions, a potential difference existed between the metal and its solution. Depending upon the actual conditions, such as ion concentration in solution, a natural or "equilibrium" value of potential is established which is characteristic of the metal in that solution under those conditions. Actually there is a continual interplay of ions or electric charges between the metal electrode and the solution, minute electric currents passing back and forth. These, however, are so small and so balanced that there is no change either in the solution or in the electrode surface and the "equilibrium" voltage, mentioned above, is therefore established.

Now if current of some definite value is passed from solution to electrode or vice versa, then the potential difference between the electrode and the solution is changed, for reasons which will be discussed later. This change in potential difference as compared with the equilibrium value is called the *polarization voltage* or merely *polarization*. Thus, if we call V_e the equilibrium voltage when the electrode merely dips into the solution, and V_I the voltage when current I is passing, then

$$V_I - V_e = V_p$$

and V_p is the voltage due to polarization. Anything that happens to decrease this difference is called *depolarization* and the agent responsible is called a *depolarizer*.

Let us consider the classical copper sulfate plating solution, with a copper anode and a copper cathode. If a current were passed through such a solution and if no polarization existed, the only applied voltage that would be necessary would be that needed to overcome the electrical resistance of the solution. We have already seen, above, that this voltage, V_{sol}, is equal to the current flowing multiplied by the bath resistance: $V_{sol} = IR$. At each electrode the same voltage exists, since the electrodes are the same in this case; the potential for dissolving copper at the anode just balances the potential for depositing copper at the cathode. Actually, such a situation exists only at the very moment that a circuit in a plating bath is closed. Now as some particular current continues to flow, the potential at the anode becomes more positive and that at the cathode more negative, and a steady state is obtained in the solution corresponding to the current being used. At this steady state, the voltage necessary to maintain the flow of the current "I" is no longer $V = IR$ but must be increased by V_{pc}, the cathode polarization, and V_{pa}, the anode polarization. This extra voltage may be considered as being necessary to offset the reverse voltage set up by polarization at each electrode, and, in fact, if the main circuit is suddenly broken, but a high resistance voltmeter is left connected, this reverse polarization voltage will be shown on the voltmeter, in a direction opposite to that of the externally applied voltage, i.e. the generator voltage.

So far we have talked only of polarization at one value of current and have assumed that conditions in the solution have become steady at that current. For the remainder of this discussion, it will be assumed that steady conditions have always been reached for each value of the current considered. At zero current there will be no polarization, of course. As the current increases, the value of both the anodic and cathodic polarization increases, but not necessarily to the same degree. The situation for the above copper solution, showing the effect of polarization on bath voltage as described above, may be illustrated as in Figure 13. At any current, such as I, the small horizontal arrows indicate the magnitude of the voltage due to polarization or resistance in the solution: A B is the resistance voltage, B C the cathode polarization voltage, C D the anode polarization voltage. The distance A D represents the total voltage across the bath and is of course the sum of the above. A further illustration will be cited later but first it is advisable to inquire into the types and causes of polarization.

It is evident that the changes that take place due to the passage of current, which cause polarization, must take place either in the solution near the electrodes or on the surface of the electrodes themselves. We shall therefore consider polarization from

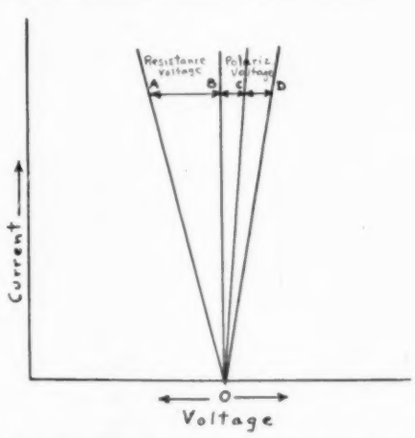


Fig. 14. Drawing illustrating approximate variation in plating bath voltage components.

these two points of view. Various names have been given to certain degrees of polarization and to the various components of the bath voltage but there has been an unfortunate lack of agreement in terminology leading to a rather confused and inconsistent situation. The author is, therefore, deliberately omitting such names until the end, when a proposed standard terminology will be described.

Considering first the solution, the reader will recall that the passage of current is effected by the movement of the ions in the solution. The ions move, mainly, due to the applied electromotive force which attracts or repels them to each electrode and also by natural diffusion. At the cathode, in a "still" solution, as the metal ions are neutralized and deposited, they can neither be drawn in electrically nor can they diffuse in naturally with sufficient speed and in sufficient number to replace those that are plated out. The solution in the immediate vicinity of the cathode therefore gets more dilute in metal. As this happens, it becomes more difficult to deposit the fewer remaining metal ions and a higher voltage, i.e. the polarization voltage, must be used to do so. This subject of increased difficulty in plating metal from dilute solution of its ions has been more fully discussed in a previous chapter.

Other effects besides polarization also occur. For example, the more dilute, and therefore lighter, solution tends to rise to the upper regions of the bath. The heavier anode solution, described below, aids in this. If no agitation is used therefore, strata of solution, of different concentration, are formed. As a result, in a "still" tank containing "deep" pieces, the bottom part of the cathode receives a heavier deposit from the denser solution. Other factors, of course, also contribute to this. Sometimes, one part of an electrode may act as a cathode and the other end as an anode. The author has seen anodes, only 18 inches long, which dissolved on top and grew heavier on the bottom unless the solution was actively agitated.

In addition to the above *concentration polarization*, as the metal ions disappear near the cathode, other elements may deposit such as hydrogen. In the latter case, the solution near the cathode becomes more alkaline. Changes in both concentration and composition therefore take place which contribute to polarization. In the case of cyanide solutions, there is the time factor for the ionization of the complex cyanide radicals as compared to the simpler ionization of such salts as copper sulfate, for example. For this reason, cyanide solutions generally, but not always, show higher polarization values than do the simpler baths. The effect

of this tendency on throwing power will be discussed in a subsequent chapter.

At the anode, an analogous situation exists. In the case of an anode dissolving at high efficiency, metal ions are formed faster than they can be removed from that immediate vicinity so that the solution gets more and more concentrated. Simultaneously, it becomes more difficult to dissolve the anode in a solution already concentrated with its ions, so again the voltage must be increased if the same rate of dissolution (i.e. anodic current density) is to be maintained. This increase in voltage is called *anode polarization*. Sometimes it may happen that the solution near the anode becomes so concentrated that the metal salts begin to crystallize out of the solution on the anode, thus insulating it so that very little current can pass unless the voltage is greatly increased. Such a situation may arise in the case of acid copper solutions, especially if the temperature of the bath drops too low. At other times, the metal dissolved may react chemically with the solution and form insoluble products which similarly insulate the anode, or may thus remove the particular ions in the solution which assist in the dissolution of the anode. Thus in a silver cyanide solution, the free cyanide prevents the formation of the insoluble silver cyanide as long as there is enough to permit the following reaction:

AgCN	+	KCN	=	$KAg(CN)_2$
Silver cyanide Insoluble		Free potassium cyanide		Potassium silver cyanide Soluble

The silver cyanide, AgCN, tends to be formed as the silver dissolves from the anode, thus:

Ag^+	+	CN^-	=	AgCN
Silver ions		Cyanide ions		

The free cyanide, by keeping the anode and solution clear, thus acts as a depolarizer. Chloride serves a similar function in nickel solutions, Rochelle salts in copper solutions, caustic soda in tin solutions, etc.

It is evident that concentration polarization is reduced by whatever will make the solution immediately next to the electrode of the same composition and concentration as the main bulk of the bath. Regardless of what steps are taken to make the cathode or anode solutions (called respectively *catholyte* and *anolyte*) uniform, there will always be a film of solution adjacent to the electrode which differs in composition from the rest of the bath. For most practicable purposes, however, this irremovable, residual film can be ignored. Much interesting work has recently been done in studying cathode films, which in themselves form an important phase of electroplating, and a resume of this may form the subject of a future article. The reduction in the amount of catholyte or anolyte, however, reduces polarization. The most common way to accomplish this is to agitate the solution. The influx of ions, due to agitation, to the diluted solution near the cathode reduces polarization and therefore permits increased current density. The reduction in the concentration of the solution near the anode also reduces polarization. Increasing the temperature acts in a similar manner to agitation, by increasing the rate of diffusion of the ions. Other factors which affect this type of polarization are of course the composition of the solution and the current density.

So much, for the moment, for polarization due to changes in the solution. The other phase of polarization has to do with conditions on the surface of the electrode and is important enough to have been given the special name *overvoltage*, especially when a gas is liberated.

(To be continued)

Patent Digest

Descaling Chromium-Iron Alloys

U. S. Pat. 2,261,744. J. N. Ostrofsky, assignor to Rustless Iron & Steel Corp., Nov. 4, 1941. A process of removing surface scale from chromium alloy iron products which includes cathodic treatment in fused caustic for at least one-half minute and at a current density of at least 25 amp./sq. ft. in order to open up the scale, followed by an anodic treatment in said caustic of about the same duration and current density to penetrate the scale and change its character, and then by a second cathodic treatment in said caustic for a like period and current density in order to decompose the scale permitting its subsequent ready removal.

Electroforming

U. S. Pat. 2,255,440. W. R. Sherman, Sept. 9, 1941. Production of stencils electrolytically by painting the design with casein paint on a wax coated base, applying metal or graphite powder to the whole matrix, as a conducting film, removing the coated casein paint areas with a material which will not dissolve the wax and electrodepositing copper on the metal coated areas, after which the deposit is removed from the waxed base.

Pickling Waste Recovery

U. S. Pat. 2,255,445. D. R. Clarkson, assignor to Ella Van Gorder, Sept. 9, 1941. A method of treating ferrous sulfate from waste pickling liquors to obtain ferric oxide and sulfuric acid by high temperature decomposition and oxidation of the liberated sulfur dioxide.

Plating Machine

U. S. Pat. 2,255,922. V. Finston, assignor to The Meaker Co., Sept. 16, 1941. A rapid transfer mechanism for a return type conveyor plating machine.

pH Electrode

U. S. Pat. 2,256,733. H. H. Cary and W. P. Baxter, assignors to National Technical Laboratories, Sept. 23, 1941. A glass membrane type pH electrode of novel design.

Pickling Nickel Bearing Alloys

U. S. Pat. 2,253,334. P. R. Kalischer, assignor to Westinghouse Electric and Mfg. Co., August 19, 1941. The process of treating nickel: iron base alloys in which the nickel plus iron content constitutes the predominating alloying constituents, comprising immersing in a cold dilute acid bath, such as 5-20% sulfuric acid containing an inhibitor wherein the alloy is an electrode, subjecting the alloy electrode to the action of a low voltage alternating current having a current density of from 5-15 amp./sq. in. at a voltage of from 2 to 12 volts for a period of time up to 30 min. while maintaining the bath cold during the entire period of treatment to remove the intergranular oxidation and give the alloy a clean smooth surface, the inhibitor retarding solution of the nickel-iron base alloy. This is followed by a neutralizing dip. An inhibitor such as quinoline may be used in the amount of 1% by weight of the electrolyte.

Cleaning Method

U. S. Pat. 2,254,492. G. H. Orozxo, assignor to Gilron Products Co., Sept. 2, 1941. The method of removing foreign matter such as greasy substances, superficial carbon, wax and soaps from a metal article comprising heating the article for a predetermined period by immersion in a bath of oil for a sufficient time to raise the surface of the article to a temperature materially above the boiling point of water, and immediately dipping the article in an aqueous alkaline detergent bath heated to about the boiling point of said bath. The oil is preferably kept at 250° F., although it may be kept at any temperature below the flash point. Any commercial alkaline cleaner is satisfactory for the detergent bath.

Protecting Coating

U. S. Pat. 2,255,978. H. L. Kohler, assignor to A. A. Kramer, Sept. 16, 1941. The method of repairing a rupture in the zinc coating of a galvanized metallic sheet, comprising the spreading a soft, creamy, putty-like amalgam of mercury and tin containing from 45% to 75% mercury by weight over the surface of said sheet at and adjacent said rupture, rubbing the resultant amalgam over said rupture, removing all the excess amalgam and permitting the resulting amalgamation, over the entire area over which the same was spread, to proceed undisturbed throughout the thickness of said zinc coating over said area until a hard amalgam coating over said area having the spangled appearance of the galvanized coating on said sheet, is produced.

Coating Sheet Steel

U. S. Pat. 2,258,327. A. A. Kramer, Oct. 7, 1941. A steel sheet having a corrosion protective coating comprising an inner ferrous-zinc alloy zone adjacent the steel base, an intermediate zone of substantially pure zinc and an outer flexible zinc alloy zone containing a relatively small quantity of a non-ferrous metal having a lower melting point than zinc such as tin and lead.

NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

Expanding Abrasive and Polishing Wheels

Jos. L. Howland Co., 341 Frankfort Ave., N.W., Cleveland, Ohio, have announced a line of their patented expanding abrasive and polishing wheels in sizes of from 4" diameter with 1½" face to 12" diameter with a 4" face.

These wheels are used with abrasive bands containing the polishing grit. These bands can be quickly applied to the wheel and are held firmly in place and thus the wheels

Assembled abrasive wheel.

are termed "Jiffy Wheels". The use of the abrasive bands means that no break in of the wheel surface is required. The wheel runs true, needs no balancing and is of constant diameter, giving, therefore, constant surface speeds at all times. When the belt is worn out, it can be quickly replaced with a new one and changes from various grit sizes can be made as readily.

Abrasive bands are available with grit sizes of 36, 40, 50, 60, 80, 100 and finer. Smaller sizes of polishing wheels from 4" to 8" in diameter are used on portable tools and the larger sized wheels are used on the floor type pedestal lathes.

Polishing Wheel Grain Cements

Park Chemical Co., 8074 Military Ave., Detroit, Mich., have developed a line of grain cements for polishing wheels which are used as cold binders to attach abrasive grains to the face of polishing wheels or belts. They can also be used to cement polishing wheel sections together.

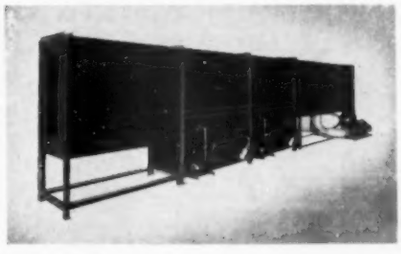
They are made from a silicate base mixed with organic and inorganic fillers, and depending upon viscosity and strength desired, they can be varied to suit individual operating conditions. It is stated that they can be used for setting up any size polishing wheel, to replace glue, and to be more generally satisfactory than glue for all grain sizes except for fine grain.

Advantages claimed are that the cements are clean, odorless and not subject to bacterial attack. No heating pots are required for application of cement. Wheels can be air dried, in ovens, or with infra-red energy lamps. Longer life and greater economy are claimed for cement headed wheels over similar wheels headed with abrasive bound with glue.

A cold sizing compound is also available for sizing wheels or belts to provide a strong bond between wheel and cement head. Five different types of grain cements are available having specific properties for various types of work.

Washer and Dryer for Chromium Plated Parts

One of the newest products washing machines developed by The Alvey-Ferguson Company, Cincinnati, Ohio, is the one illustrated. Designed especially to wash chromic acid off heavy chromium plated parts, then dry the parts before packing, this washer and dryer is equipped with an overhead trolley conveyor to transport the parts through a succession of cold, hot and distilled water rinses and the dryer.

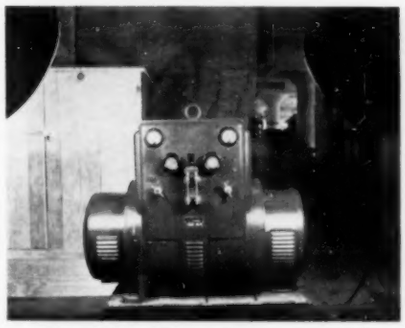


Washer and dryer for chromium plated parts.

Special nozzles are provided for atomizing the spray. The steam-heated, blow-off type dryer recirculates the air. Tanks and chambers are constructed of ¼" copper bearing plate. Other products washers recently developed by The Alvey-Ferguson Company are being used in National Defense Work for washing cartridges, shells, gun barrels, engine parts, etc.

Line of Anodizing Machines

Motor Generator Corporation, Troy, Ohio, announce a complete line of anodizing machines available from 125 through 875 am-



Motor generator for anodizing.

peres at 20, 40, or 50 volts D.C. Motor sizes range from 7½ through 55 horsepower generating from 5 to 35 KW. Each machine is furnished complete with control cabinet ready for anodic treatment of aluminum and its alloys whether the Alumilite, Bengough-Stewart, or Bureau of Standards process is used in the operation.

Features of the anodizing sets are: Constant speed guaranteeing constant voltage

Professional Directory

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SALT SPRAY TESTING — CERTIFIED TO MEET ARMY AND NAVY SPECIFICATIONS. Testing of deposits-thickness, composition, porosity. Solution analyses, plant design, process development.
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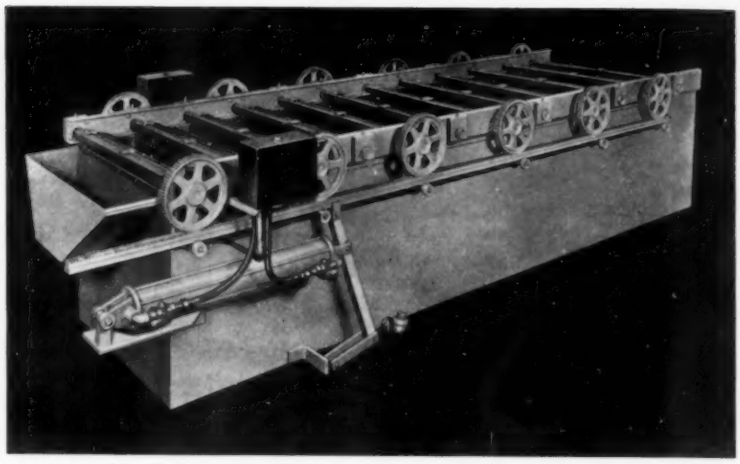
Metal Finishing Consultant
Plating plants streamlined for defense work.
233 W. 26th St., N. Y. C.

and close control over the entire current range. Positive voltage regulation insures continuous capacity with high overall efficiency. Compact single unit construction, ball bearing mounted, offering longer life with less maintenance.

Units are equipped completely with separate exciter; control cabinet housing an accurate reading ammeter with shunt-voltmeter; exciter and generator field rheostats; double pole, single throw work circuit switch; positive and negative terminal studs; and across-the-line switch giving overload as well as under voltage protection or release to the motor.

Automatic Parkerizing Machine

The Udylite Corp., Detroit, Mich., announce the development of a new automatic parkerizing machine capable of processing large quantities of small parts. It is said that this machine is ideal for those manufacturers who have large national defense contracts involving the production of .30 and .50 calibre steel machine gun links, Garand rifle clips, miscellaneous machine gun parts and other small parts which require the Parker finish.



Automatic Parkerizing machine.

The machine is a hopper type unit air or hydraulically driven according to the desires of the customer. The parts are loaded in batches at one end and progressively transferred through the various dipping tanks required for the Parker process. The machine is fully automatic. No manual handling whatever is required for the complete Parkerizing cycle including cleaning, rinsing, parkerizing, rinsing, baking and oiling. Each batch remains a separate unit throughout the entire cycle and one load cannot be mixed with another. The machine is completely hooded to conserve heat. All parts of the machine are easily accessible for replacement, as the construction is exceedingly simple. There are few moving parts.

Specific advantages claimed for this type of machine are savings in floor space due to eliminating the necessity of wide aisles near the individual units, savings in labor, savings in material, power and cost of installation. The removal of the operator from over the tanks allows him to increase his productive capacity as he is not endangered by fumes. The machine is timed by an electric clock and the maintenance of the entire machine is stated to be low because of simplicity of construction.

The machine may be inspected in the manufacturers' plant by interested parties.

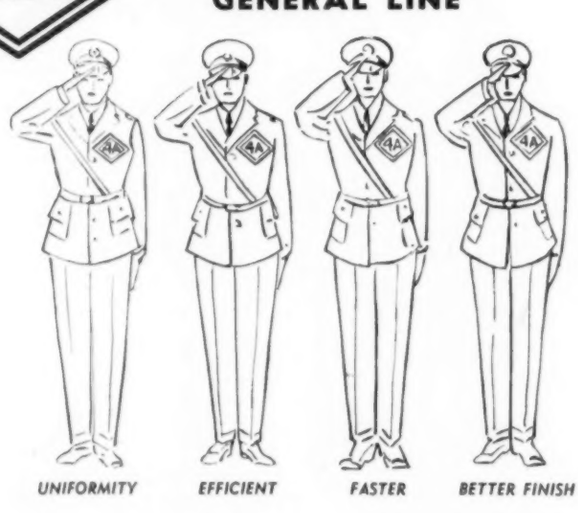
Finger Guard

A practical finger guard, or finger stall, combining tough leather and flexible lastex has recently been designed by the Industrial Gloves Company of Danville, Illinois. This new safeguard is comfortable, clean, easy on, easy off, light weight and durable. Gives protection on fingers and thumb, in any combination, to buffers, polishers, sanders, grinders, operators of stamping-out presses, assemblers of small parts, book binders, trimmers, mechanics and machine operators, both women and men. May be worn *under* glove for extra protection. Does away with tender skin due to taping fingers and the frequent trips to First Aid room for tape or bandage. If worn with leather on back of finger, Steel-Grip finger guard protects knuckles from raps, cuts, abrasions. Illustration shows grain leather and lastex combination. May also be had in

ARE YOU PREPARED TO DEFEND YOUR PRODUCTION LINE?

4A

FOR POLISHING COMPOUNDS CALL ON HARRISON'S GENERAL LINE



UNIFORMITY EFFICIENT FASTER BETTER FINISH

4A symbolizes these four features which you require for high speed polishing, mirror finishing of all kinds of steel, including stainless steel, carbon steels and hard-to-buff alloys. Use it on any kind of a wheel, soft, medium or hard.

CEMENT AND THINNER

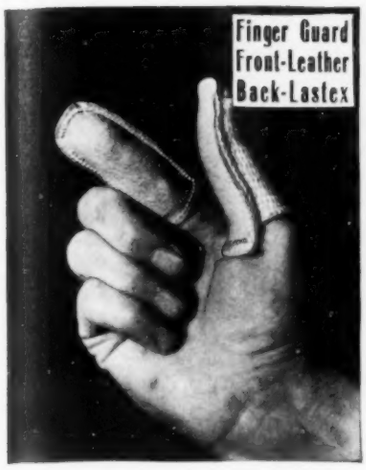
NO WORRY ABOUT GLUE SHORTAGE WITH 4A CEMENT AND THINNER. Polishing wheels are free cutting, long lasting and economical when set up with 4A Cement.

Tell us your problem and samples of compound or cement will be sent.

HARRISON and COMPANY

Haverhill, Mass.

ADEQUATE RESERVES READY FOR PROMPT SHIPMENT



Finger and thumb guards for buffers, polishers, etc.

heavy split leather, light weight kid leather or wool felt. The lastex feature makes Steel-Grip finger guards snug fitting, always flexible and porous for ventilation.

Pickling Brass Cartridge Cases

A troublesome problem in the manufacture of brass cartridge cases has been solved through the use of a common and well-known chemical, ferric sulfate, according to J. J. Healy, Jr., development director of the Merrimac Division of Monsanto Chemical Company, Everett, Mass.

Ugly red cuprous oxide stains and black smut are frequently left on the surface of the brass after heat treating operations used in cartridge case manufacture, and they have been difficult and sometimes impossible to remove by the usual acid pickling methods, according to Healy. By using a pickle solution containing ferric sulfate in addition to the usual acid, however, complete removal of stain is being achieved, Healy said.

Sulfuric acid alone will remove the more common black cupric oxide, but it is not effective against smut or red stain, with the result that these blights have been a frequent cause of trouble in the pickle room, he said.

To assure complete elimination of stain, ferric sulfate should be used in each pickling operation, starting with the first anneal. If any red cuprous oxide or black smut remains after pickling, and is subsequently drawn into the piece, it becomes difficult to remove.

The use of ferric sulfate in pickling cartridge cases is claimed not only to improve final finish but to produce a finish more satisfactory for intermediate draws.

A Plastic Material to Replace Copper in Industry

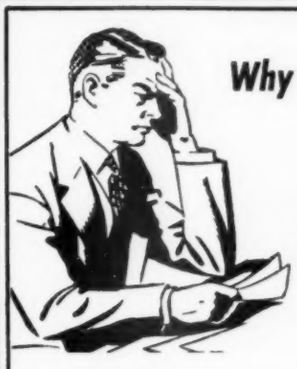
With all copper under strict allocation through a ruling of the Office of Price Administration and Civilian Supply, The Dow Chemical Company has announced that a flexible, semi-transparent tubing of thermoplastic "Saran" is available to industry as an alternative for copper and other metal tubings.

Developed through years of research, this tough, chemically resistant tubing may be used in many applications previously demanding copper except where high temperatures and very high pressures are encountered. Also, Saran tubing has been tested and proved suitable to replace such strategic materials as nickel, stainless steel, copper and ceramics in several fields where its unusual properties are advantageous.

Saran is characterized by unusual toughness and resistance to moisture, brines, solvents, acids and alkalies. Another feature of this plastic material is that it may be used for short periods of time at temperatures of two hundred and fifty degrees to two hundred and seventy-five degrees Fahrenheit, although its strength and resistance are somewhat reduced at these elevated temperatures, Dow laboratory men announced.

Available in sizes one-eighth inch to five-sixteenths inch outside diameter with wall thicknesses varying from 0.030" to 0.062", this tubing may be joined by Parker Standard Tube Couplings and S.A.E. or other flare type fittings. Already the Mueller Brass Company of Port Huron, Michigan, is developing fittings for Saran tubing which permit the construction of a tubing system in which contact between such fittings and the material conveyed is entirely eliminated.

Saran tubing joined with "B" Parker Standard Tube Couplings withstood a pressure of fifteen hundred pounds per square inch without rupturing or leaking. In a fatigue test Saran was flexed through an angle of fifteen degrees, one thousand seven hundred and fifty times per minute for two



Why Worry About Metal Shortages When You Can Use

EBONOL

Reg. U. S. Patent Office

THE JET BLACK CORROSION RESISTANT FINISH FOR IRON AND STEEL

Check These Features:

- Fast Blackening by Immersion in Only ONE Bath
- Deep Penetration — No Red Stains
- Highest Corrosion Resistance
- Simple and Economical to Operate

We are confident that EBONOL is *the* outstanding blackening process for iron and steel and all we want is an opportunity to prove this to you. Hundreds of parts now being made of brass, aluminum, or zinc and lacquered, enameled or plated, can be advantageously made of EBONOLIZED STEEL. Haircurlers, trunk hardware, guns, fan parts, pencil parts, tools, toys, bearing races, electrical apparatus, electrical appliances, switch parts, clock parts, pins, lamps, drapery hardware . . . .

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million five hundred thousand cycles without failure, while standard one-quarter inch copper tubing failed after about five hundred cycles in the same test.

This indicates that Saran tubing would be superior to copper tubing for those applications where excessive vibration is encountered.

With the use of copper prohibited to non-defense industries, the introduction of Saran tubing permits maintenance of production in some instances where the lack of copper might have serious economical effect.

Blackening Process for Steel

E. F. Houghton & Co., Third, American & Somerset Sts., Philadelphia, Pa., have announced the development of a process called, "Houghto-Black", recommended for chemical blackening of steel.

An adherent jet black oxide is obtained by immersion in a solution of "Houghto-Black" salts operated at the boiling point of the solution, namely, 290° F. The solution is made simply by adding the salts to a specified quantity of water. A welded low carbon steel tank is used. Previous to blackening, the work is cleaned in a manner similar to that for plating. Blackening is accomplished in five or more minutes depending upon the condition of the steel. A cold water rinse and a hot water rinse at 160-180° F. follow the immersion in the blackening solution.

A soluble oil dip for a final luster and surface finish protection may be used, but not where work is to be subsequently lacquered or enameled.

Costs of applying the finish are said to be low and the applicability is very wide. In addition to offering attractive appearance and corrosion resistance, the finish is recommended as an undercoat for lacquers or other organic finishes. It is also stated that the blackened surface assists in reducing friction in the break-in of wearing surfaces, by helping to hold the lubricant in place to prevent rupture of the oil film.

A four-page folder is available describing this process.

New Drum Opener

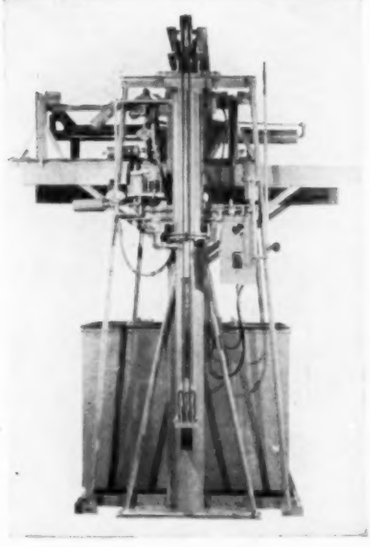
A new semi-automatic drum opener is announced by The Turner & Seymour Manufacturing Company of Torrington, Conn. Known as the "Westco Drum Opener," it is said to be characterized by speed and ease of use, simplicity of construction and elimination of the injuries associated with the usual hammer-and-cold-chisel method of opening drums.

Claimed to be the first successful drum opener, the apparatus cuts a smooth-edged opening in straight-chime metal drums up to 35″ in height. The corrugated cast iron base can be bolted to the floor. Four steel uprights support the cutting unit, which is counterbalanced for easy adjustment to the height of drum. After adjustment, the cutting unit is locked in position. By closing the cutting unit lever, the drum is perforated. The over-all height of the drum opener is 50″.

Commenting on the need for such a device, an official of The Turner & Seymour Manufacturing Company said, "Opening drums with a hammer and cold chisel presents a constant danger of injury from either the tools or the ragged edges of the opened drum. If the open wound comes in contact with cyanide, potash or other such contents of a drum, blood poisoning often develops. With manpower so urgently needed by defense and non-defense industries alike, the nation cannot afford absenteeism or loss

Operator opening drum with semi-automatic drum opener.

Crown Pick-up Unit



...MACHINE...

A UNIT TYPE TRANSFER CAPABLE OF HANDLING SEVERAL TANKS AT ONE TIME.

●

...USE...

FOR A SERIES OF OPERATIONS WHERE THE WORK MUST PASS THROUGH SEVERAL TANKS, AS THE CLEANING AND RINSING OPERATIONS, FOR A SEMI-AUTOMATIC PLATING TANK.

CROWN RHEOSTAT & SUPPLY CO.

1910 MAYPOLE AVENUE :-: :-: CHICAGO, ILLINOIS

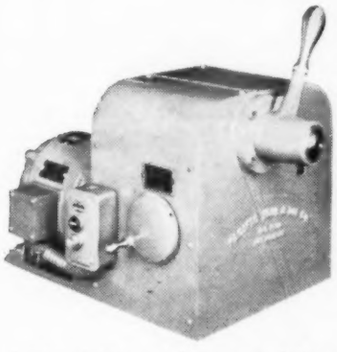
of efficiency through injury. It is high time we opened drums with the same safety, speed and ease with which our wives open a can of beans."

Details and prices of the Westco Drum Opener are available from the manufacturer.

Variable Speed-Lathe

A new Second Operation Machine, known as the "Pacific Vera-Lathe" with an infinite number of variable spindle speeds from 5000 r.p.m. down to 1250 r.p.m., with a hollow spindle design and a novel collet operating mechanism, has been introduced on the market by the Pacific Tool & Die Co., 1225 East 63rd St., Los Angeles.

It has been especially designed for polishing, buffing, burring, filing, sizing, finishing and lapping round parts, and is said to embody several principles not usually found in machines of this type. One feature is the collet operating mechanism on the front end of the spindle. This design saves a great amount of time by permitting the spindle to rotate while the work is inserted into the collet and eliminates the attendant wear and tear caused on machines that must be stopped to chuck the work. This collet can also be foot-operated if so desired. Interchangeable spindles can be furnished to accommodate a chuck or other applications.



Semi-portable variable speed lathe.

The spindle is ball-bearing mounted, on specially selected bearings; has a hole its entire length, through which passes a hollow draw tube with a 13/16" bore for holding the ¾" maximum capacity collet. The tension of the collet can be easily adjusted to the proper required amount by a simple turn of a round adjustment handwheel located on the back end of the spindle. It is also simple to change collets by this same handwheel.

Various spindle speeds are quickly obtained by the turning of a handwheel located on the side of the lathe for selecting the proper and most efficient speed for the work in question. Usually high speeds are required for lapping, polishing, and buffing, while the lower ranges are found more suitable for burring and filing.

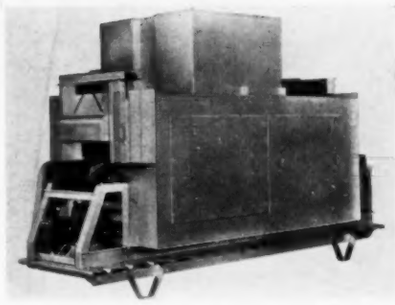
While the speeds normally offered are 5000 r.p.m. down to 1250 r.p.m., in infinite variation, other combinations can be furnished on request. The lathe is motorized with a ½ horsepower electric motor, either single or three phase (optional) and is completely wired, including starting switch, and ready to run.

Heat Treating Furnace

A new conveyor type convection heated low temperature heat treating furnace has been developed by The Gehnrich Corporation, Long Island City, N. Y. for preheating, drawing, normalizing, holding, annealing, stress relieving and other heating operations up to 1250°F. on relatively small metal castings, slugs, stampings and forgings. It provides continuous, relatively fast heat treatment within close temperature limits.

This type of furnace or oven is easily applicable also for drying or baking of bulk chemicals and other process materials, ceramic and glass products and many other materials continuously. For this purpose, preheating and cooling sections can be easily added to the heat processing chamber.

Taking advantage of the high temperature resistance of alloy steels, the furnace has an all alloy steel interior, eliminating



Convection heated conveyor type heat treating furnace.

the need for refractory linings or brick and its consequent maintenance. The furnace walls are made of patented, insulated Dual Panels packed with mineral wool blankets. This construction eliminates through metal joints and consequent heat losses and provides for ready expansion and contraction of the walls, easy assembly, enlargement

PROTECTIVE COATINGS

Specifically Suited To EACH Of Your Needs

No one protective coating material can be completely effective through all types of processes . . . in all acids and all solutions . . . under all production conditions. That's why there is a *complete line* of "Miccro" products —to furnish the protective qualities required to meet each individual need for plating rack coatings, masking parts for hard chromium plating and other purposes.

For instance, there are five types of Miccro Supreme Stop-Off Lacquers. Each has its own characteristics and is recommended for specific coating applications. Miccrolite and Miccroflex offer certain features which make them ideal for use under many conditions encountered in cleaning and plating operations.

When you use a protective coating material, be sure that it is particularly suited to *your* requirements. Full information on the "Miccro" coatings which will prove most effective for your type of work—and will be most adaptable to your production routine—is yours for the asking. Call the "Miccro" distributor in your locality or write for completely descriptive literature.

Miccro Supreme

STOP-OFF LACQUERS

•

MICCROLITE

•

MICCROFLEX

Developed and Manufactured by Experienced Platers

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and reallocation, if the need arises.

The heat source consists of electric heating elements. A fan of ample capacity located above the oven draws the heat from the heaters and discharges it over the full length and width of the oven. This heated air permeates the work, returns to the heater and through the fan, thereby creating a complete recirculating system which effects heat savings and produces greater uniformity of heat treatment.

Thus the benefits of convection heating are produced by drawing the heat from the electric heaters out of the furnace and then blowing it into the heating chamber so that the work travelling the full furnace length is subjected to equal and uniform heating at the desired temperature, within a few degrees plus or minus. If desired, the same furnace can be arranged for heating by means of a gas or oil fired external air heater.

The conveyor consists of a wire mesh belt which runs over steel drums at both ends of the oven and is driven by a motorized variable speed drive.

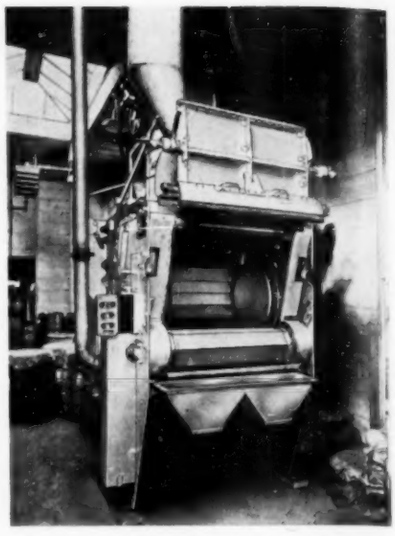
Simple Barrel Loading Device

At the Palnut Company, Irvington, N. J., a blast cleaning operation to remove sand and scale is the final processing step in the manufacture of their metal parts.

After the few minutes blasting time required, the cleaned parts are unloaded directly from the airless abrasive blast cleaning machine into shipping barrels. To prevent spillage of the small pieces in loading the barrels, a simple double hopper trough feed was devised.

This they fastened across the front of the unloading chamber of the "Wheelabrator Tumblast." Since it is slightly wider than the discharge mouth of the machine all parts fall through the trough into the two barrels.

With the addition of this ingenious barrel-loading arrangement, the Palnut Company eliminated the extra handling brought about through the hauling of cleaned material to the shipping department in containers and then later transferring the parts into shipping barrels.



Double hopper trough feed for blast cleaning machine.

In cases where parts are cleaned which demand further processing after the blasting step, this trough does not interfere with their discharge from the Tumblast to any other kind of suitable tote boxes for conveyance to other departments in the plant.

Steel Bearings Dried Quickly by Forced Convection Heater

Flexible steel bearings made by the Harris Products Company, Cleveland, Ohio, are dried quickly and thoroughly by a novel drying equipment evolved by this company's engineers.

Ball bearings being dried by forced-convection electric heater after washing with soap.

After a coating of petrolatum is washed from the bearings in a solution of strong soap, the bearings are placed on a screen tray which just fits the top of the box-like affair shown in the photograph.

Air from a General Electric 5000-watt forced convection unit heater is then blown into one end of the enclosing box, and passes up through the parts lying on the screen tray, quickly and effectively drying as many as 50,000 bearings per day.

SPEED UP
YOUR DEFENSE OUTPUT
WITH
COWLES CLEANERS

Clean all metal surfaces
—QUICKER!
—BETTER!
—RIGHT THE FIRST TIME!

THE COWLES DETERGENT COMPANY
CLEVELAND, OHIO

Mail this coupon TODAY!

The Cowles Detergent Company, *Metal Cleaner Department*
7016 Euclid Ave., Cleveland, Ohio

*What do you recommend for this type of cleaning?*_____

Company _____

Street and No. _____

City and State _____

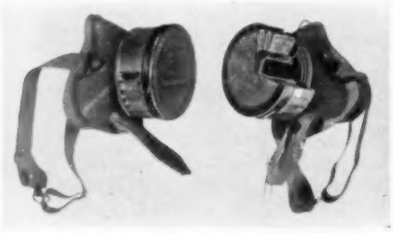
Signed _____

Title or Department

Respirator for Dust-laden Air

A new respirator, which is said to afford maximum protection against the inhalation of pneumoconiosis-producing and nuisance dusts, has just been announced by the DeVilbiss Company, Toledo, Ohio.

Approved by the United States Bureau of Mines, the new "MSD" Respirator is said to embody nine unique features. These combined make it more compact, lighter, easier to breathe through, more comfortable



Respirator for dust-laden air.

to wear, and easier to clean and maintain than previous models.

In the new respirator, a compactly designed cartridge, measuring 2⅞ by 1½ inches and weighing one ounce, provides more than 41 square inches of breathing and filtering area. Multi-vane construction allows every inch of this filter to be used efficiently. This means no air restriction to cause difficulty in breathing, plus greatly increased filtering efficiency.

The filter is easily cleaned by blowing accumulated dust from vanes with an air dusting gun or nozzle, thus maintaining peak performance and requiring less frequent replacement.

The new DeVilbiss "MSD" Respirator is designed to fit, closely and without leakage, the contour of practically any face. This is reported to be an important feature, for full protection depends upon a good fit.

Manufacturers' Literature

Liquid Processing Equipment

Alsop Engineering Corp. have just issued their catalog No. 941 entitled "Alsop Hy-Speed Equipment for Liquid Processing." This catalog devotes 35 pages to describing and illustrating the company's agitators, bottle fillers, cappers, filter discs, filters, labeling equipment, mixers, pumps and glass coated tanks. Sectional drawings illustrate constructional and application features. Considerable treatment is given to the company's line of high speed portable disc filters which are being widely used in the plating field. Copies of this catalog can be obtained by writing to Alsop Engineering Corp., Milldale, Conn.

Protective Coatings Booklet

"The Tocol Line" is the name of a new booklet just issued by *Protective Coatings, Inc.*, of 10391 Northlawn, Detroit, Mich.

H. Tom Collord, president of the company announces that this is a limited edition containing complete information about and description of all of the items in the Tocol Line of protective coatings, including synthetics, specialties, rubber, etc.

Copies of the booklet will be mailed free to interested parties.

Rubber Lined Equipment

Paramount Rubber Co., 10401 Northlawn, Detroit, Mich., have recently issued a folder illustrating, pictorially, various objects coated by the company's seamless rubber lining process. Objects discussed and illustrated that have been coated with rubber include large tanks for pickling, structural steel work, fume stacks, nickel plating tanks, pickling baskets, valves, anode savers and various plating equipment.

Pumps for Industrial Uses

Practical information concerning pump adaptation for a wide range of duties under varying conditions is the theme of the new industrial catalog just published by *Pomona Pump Co.*

This brochure contains not only a profusion of illustrated case histories of varied applications, but also presents many practical drawings for laying in this type of pump.

A free copy will be supplied by calling or writing Pomona Pump Co., 206 E. Commercial Street, Pomona, California.

Recording Instruments

C. J. Tagliabue Mfg. Co., Park & Nostrand Aves., Brooklyn, N. Y., have recently issued their catalog No. 1210 entitled "Tag Recording Instruments for Temperature and Pressure". Sectional drawings and photographs clearly illustrate the various makes

OUTLAST
others 4 to 1
...handle BIGGER PAYLOADS

Monel pickling baskets boost production. Use of light-weight welded construction conserves strategic materials.

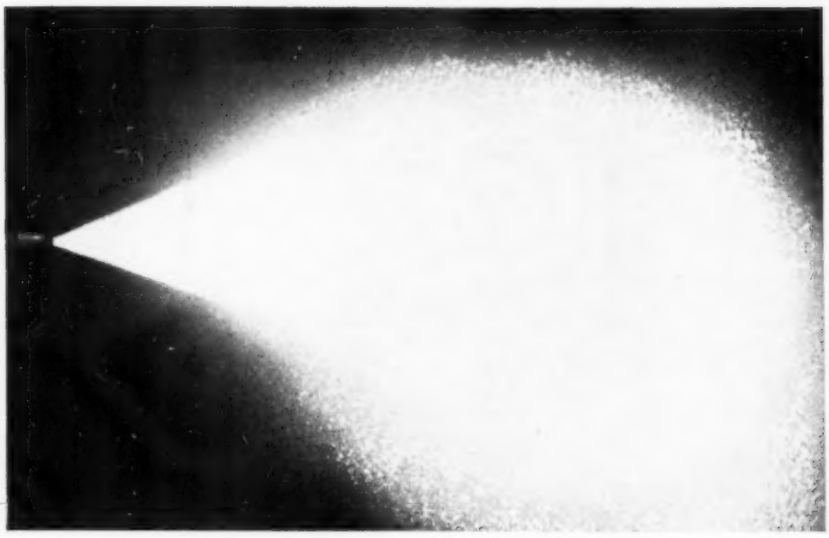
In recognition of outstanding achievement in producing for National Defense, the Navy Ordnance Award was presented to the Huntington Works of The International Nickel Company, Inc., on August 13, 1941.

In the defense industries, with the ever present material shortages, it is no time to bank on pickling baskets that won't stand up. That's why it's more important than ever to use Monel. Tough, wear resisting Monel takes the hardest kind of knocks and comes back for more. Lightweight welded Monel construction means less basket and more payload...saving time and speeding production. Consider the Monel baskets shown above as built by Rolock Inc., Southport, Conn. Used for pickling brass, steel and bronze screws in a 90% solution of 20 Be[1] muriatic acid, each handles a 150 pound load. Replacing steel ones these Monel baskets have lasted four and a half times as long and are still going strong. Learn how you can take advantage of light-weight Monel construction. Write for more information. Address:

THE INTERNATIONAL NICKEL COMPANY, INC., 67 Wall Street, New York, N. Y.

"Monel" is a registered trade-mark of The International Nickel Company, Inc., which is applied to a nickel alloy containing approximately two-thirds nickel and one-third copper.

MONEL



AVOID—PRIORITY TROUBLES
GET—CLEANING SPEED

If you are having trouble getting chlorinated solvents for the removal of stamping oils and drawing compounds from metal parts of aluminum, aluminum alloy, brass, bronze, iron or steel, here is good news:

Wyandotte Metal Cleaners can be applied as a spray in power washing machines to remove any type of deposit.

If the right Wyandotte Product is applied, the results are entirely satisfactory at a cost of operation ranging from one-half down to one-tenth of the cost of vapor phase degreasing with chlorinated solvents.

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of instruments and their constructional features. Standard parts are cataloged and numerous photographs show typical illustrations.

Variable Speed Lathe

Pacific Tool & Die Co., 1225 E. 63rd St., Los Angeles, Cal., just published a 4-page folder describing their semi-portable variable speed lathe.

This lathe is capable of operational speeds from 1250 r.p.m. to 5000 r.p.m. It is recommended for polishing, burring, filing, lapping, buffing and general finishing.

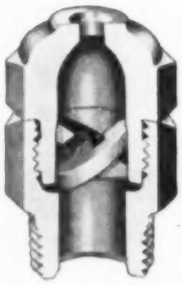
Wetting Agents

American Cyanamid & Chemical Corp., 30 Rockefeller Plaza, New York, N. Y., have just issued a 77-page booklet entitled, "Aerosol Wetting Agents". This booklet gives specifications and technical information on the surface active materials sold by the company. The booklet is profusely illustrated to show the various physical properties of the surface active materials. Thus, pictures of pouring illustrate relative viscosities of materials. Solubilities in various solutions of electrolytes are shown by photographs of graduates with various concentrations of the wetting agents in solutions of electrolytes. Valuable information is given on the phenomenon of surface tension and methods of measuring the same. The Draves test for measuring wetting power is considered. The action of wetting agents in acid, and alkaline solutions and the calcium tolerance of the company's surface active materials are discussed. The book also includes valuable sections on wetting, spreading, capillarity and penetration. Specific applications for surface active materials are mentioned. The book concludes with an extensive bibliography arranged according to subject matter.

Technical Publications

Simple Methods of Analyzing Plating Solutions

A new edition (the sixth) of a forty-eight page booklet giving in detail, simple and practical methods of analyzing plating solutions has been published by the Hanson-Van Winkle-Munning Co., Matawan, N. J.,



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Send at once for our new catalog and data sheets, or if you have some particularly difficult problem, why not let us help you with it? Our organization really has the "know how" when it's a question of spray systems, we should, they are our only product and our only interest.

Spray cleaning is faster cleaning.

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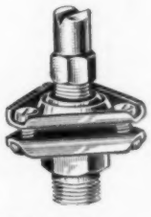

FLAT SPRAY . . . Produces a flat, hard-hitting stream. Shown here in our adjustable joint for changing angle of impact.

manufacturers of electroplating equipment and supplies. This work has now been in circulation since 1930 and has become one of the standard textbooks in its field. The methods recommended are simple and highly practical in character, and can be applied by men without extensive chemical training. A number of new features appear in this edition which are noted below.

The contents of the book include descriptions of the principles involved in analysis, the use of apparatus, the method of sampling a plating solution and step-by-step methods for the complete analysis of the following solutions:

Nickel
Black Nickel
Silver
Sulphate Copper
Cyanide Copper
Rochelle Copper
Cyanide Brass
Cyanide Gold
Cyanide Zinc
Sulphate Zinc
Chromic Acid
Alkaline Tin
Cyanide Cadmium
H-VW-M Bright Cobalt Nickel
H-VW-M Semi-Bright Nickel

The book is thoroughly indexed making it easy to find the particular analysis desired.

Full lists are given of the necessary equipment and chemicals required for the analytical work. The book contains a number of valuable reference tables covering: component parts in per cent by weight, of salts commonly used in electroplating; densities of commercial acids; electromotive series; sodium cyanide required to dissolve metal salts; acid and alkali actions on metals; electrochemical equivalents.

A new Section is included, Electrochemical Data for the Important Metals, which gives the usual cathode efficiencies; average cathode current densities; ampere minutes per sq. ft. to deposit 0.0001″ at the usual efficiency; the time in minutes required to deposit 0.0001″ at the average cathode current density and the usual cathode efficiency; all of these data for a number of the most important plating solutions. A detailed description is given, with examples, of methods of determining the thickness of deposits at various plating times and current densities. Another useful table gives the factors for the conversion of weights of metals into thickness and vice versa.

Copies of this book are obtainable on request from the Hanson-Van Winkle-Munning Co., Matawan, N. J. It is noteworthy that this company also places its laboratory at the full service of all electroplaters for instruction and consultation.

The Spectrographic Analysis of Tin-lead Solders. By D. M. Smith. Publication No. 105. Issued by the International Tin Research & Development Council, Fraser Rd., Greenford, Middlesex, England, and Battelle Memorial Institute, 505 King Ave., Columbus, Ohio.

This publication deals with the determination of aluminum, bismuth, cadmium, copper and zinc in tin-lead solders from records of their spark spectra.

Publications of Battelle Memorial Institute

More than five hundred Battelle-written books, patents, and journal contributions are listed in a new booklet issued by Battelle Memorial Institute, Columbus, Ohio, one of the country's largest industrial research organizations.

Since its beginning, Battelle has utilized the medium of the various technical and scientific journals in disseminating the results of its research in chemistry, ceramics, fuels, and metallurgy. Compiled by Thelma R. Reinberg, Institute librarian, the new booklet lists all contributions to the technological literature made by Battelle staff members during the eleven-year history of the Institute. Copies of the booklet are available upon request.

Methods for the Fabrication of Clad Steel Plate—Nickel-Clad Steel, Monel-Clad Steel, Inconel-Clad Steel. Development and Research Division, International Nickel Co., Inc., 67 Wall St., New York, N. Y.

Handbook—Office for Emergency Management. This publication can be secured from Division of Information, Office for Emergency Management, Washington, D. C., and gives the present personnel and functions of the various departments under the Office for Emergency Management, such as the Division of Information, Supply Priorities and Allocations Board, Office of Production Management, National Defense and Mediation Board.

A.S.T.M. Standards on Electrical Heating and Resistance Alloys. Prepared by A.S.T.M. Committee B-4 on Electrical Heating, Electrical Resistance and Electric Furnace Alloys. September 1941. Published by the American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. Price $1.25.

This pamphlet contains the specifications and methods of testing that have been developed by the American Society for Testing Materials for the following classes of products: Electrical heating materials; elec-

CHECK THESE ADVANTAGES OF USING NUCHAR ACTIVE CARBON

✓ IMPROVES QUALITY OF PLATING
✓ AVOIDS THE NECESSITY OF EXTRA BUFFING
✓ ELIMINATES A TENDENCY TO BRITTLENESS IN PLATED NICKEL

Periodic treatment of plating solutions with NUCHAR Active Carbon will avoid unnecessary loss of time and expense due to extra buffing operation which may be the result of plating with contaminated solutions. NUCHAR Active Carbon is now being used by a large number of electro-platers for removing these objectionable impurities quickly and inexpensively from plating solutions. Write for complete information on application and type of NUCHAR Active Carbon recommended.

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TELLS HOW . . .
—To color all types of metals and alloys
—To prepare metal surfaces for coloring
—To finish colored metals

It is comprehensive and will be of use as a reference and guide book to those engaged in metal coloring in its decorative as well as protective phases. Many of the so-called secret processes of the electroplating art are described in considerable detail with critical comments by the author.

WHAT THIS BOOK CONTAINS

Formulae and Patents
Influence of Alloying on Coloring
Difficulties Encountered
Preparation of Surfaces — Degreasing
Rust Removal — Grinding — Polishing
Cleaning — Lacquering — Waxing
Electrochemical Methods — Dipping
Rubbing and Contacting Methods — Nickel
Copper — Gold — Silver — Zinc
Brass — Bronze — Cadmium — Tin
German Silver — Aluminum — Magnesium
Varnishes — Metal Lacquers
Bronze Powders — Antiquing Imitation
Platinum Finish
Coloring and Protecting Iron — Brass
Zinc — Tin — Silver — Gold
Platinum Plating — Precipitating Antimony
Arsenic and Bismuth — Bibliography
Cathode Treatments — Anodic Metal Coloring
Protective Coats — Green Plating
Chemical Metal Coloring — Tempering
Burnishing — Phosphatizing — Rust Prevention

Book Payable In Advance
Metal Finishing, 116 John St., New York

trical resistance materials; thermostat metals; materials for lamps and radio tubes, and structural and electrical resistor materials for furnaces. It is published for the purpose of presenting under a single cover, data that the Society believes to be of importance to those who deal with these classes of products.

Due to the limited supply, this paper appears only in the first 500 copies of this publication.

Molybdenum in Steel. Climax Molybdenum Co., 500 Fifth Ave., New York, have issued revisions of their publications on "Molybdenum in Steel". The sections revised are Section 1—Introduction; Section 5—Carbon Molybdenum Steels; Section 11—Molybdenum Tool Steels; Section 12—Molybdenum High Speed Steels, General Index and Physical Property Charts.

New Books

JOURNAL OF THE INSTITUTE OF METALS. Edited by N. B. Vaughan. Volume LXVI, 1940. Demy 8 vo. Pp. 449, with 59 plates and numerous illustrations in the text. London: The Institute of Metals, 4 Grosvenor Garden, S.W. 1. (£2 net or, with *Metallurgical Abstracts,* Vol. VII, 1940, £4.)

The war has not unnaturally caused industrial concerns and research laboratories to refrain from publishing many results which in normal circumstances they would have done, on account of their being of possible value to the enemy. In particular, the applied sciences and engineering are affected by this restriction and the literature of these subjects diminished noticeably during 1940. Metallurgy, being as it is most vital to the war effort, is of course among those sciences in which caution has to be exercised in matters of publication. Nevertheless the volume of the *Journal of the Institute of Metals* recently issued (Vol. 66, 1940) in no way departs from the high standard that this journal set for itself many years ago and to which it has ever since adhered.

Here are to be found 30 papers, practically all of them embodying the results of original research and covering between them many branches of non-ferrous metallurgy. It is a pleasure to see overseas authors still so well represented; there are contributions from the United States (two), Australia (three), Norway, and Poland. Of especial importance from the practical point of view may be mentioned: "The Use of Refrigeration for Delaying the Age-Hardening of Duralumin-Type Alloys, with Special Reference to the Production of Large Pressings for Aircraft", by J. C. Arrowsmith and K. J. B. Wolfe; "The Rolling of Magnesium," by W. R. D. Jones and L. Powell; "Dynamic Tensile Properties and Stress-Strain Diagrams of Some Constructional Materials," by G. Welter and S. Morski; and "Effect of Atmosphere During Melting and Casting of Copper,"

by C. R. Hayward, M. Isawa, and E. M. Thomas. There are two papers on age-hardening phenomena, one of them by Dr. Marie Gayler of the National Physical Laboratory, who has done so much valuable work on the subject; and there is an important contribution to the rapidly growing literature of powder metallurgy by C. G. Goetzel; "Structure and Properites of Copper Powder Compacts." Two interesting review papers: "The Recovery of Metals from the Effects of Cold Work," by A. H. Cottrell and "The Structure of Liquid Metals," by A. Latin, both survey their respective fields exhaustively and have long bibliographies. A number of papers deal with the constitution of various alloy systems. The Institute's annual May Lecture, this time on "Engineering and Atomic Transmutation" by Professor J. D. Cockcroft, is reprinted here.

Altogether the present volume may be said to be as valuable as any of its predecessors; and that is saying much.

"Powder Metallurgy—a Review of its Literature" in a revised and enlarged edition is now ready for distribution by the Department of Publications of the Colorado School of Mines. This work, published as volume 36, number 4, of the *Colorado School of Mines Quarterly*, is by Clark B. Carpenter, professor and head of the Department of Metallurgy at the Colorado School of Mines. The original edition by Professor Carpenter published in October 1940 was in such demand that the supply was exhausted shortly after its publication, and many advance requests have been received for the present revision.

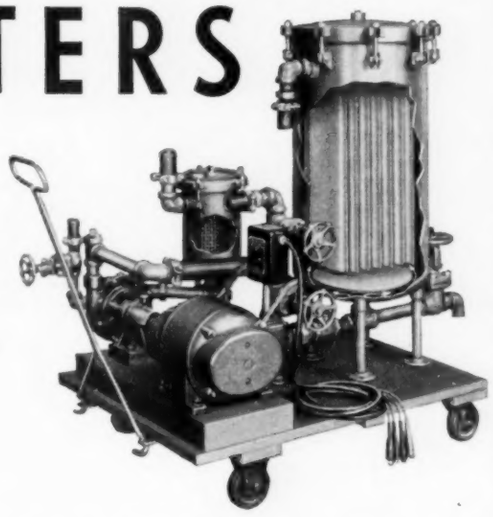
Much of the material in the original edition has been used in the revision but has been discussed more thoroughly, and a great deal of new material together with additional tables has been included. A feature of the present edition is a much larger and more complete bibliography.

Copies may be obtained from the Department of Publications, Colorado School of Mines, Golden, at a cost of fifty cents.

FILTERS

For

Bright Nickel
Nickel
Chrome
Copper Sulphate
Cyanide Copper
Brass and Zinc
Cadmium
High Speed Copper
Brite Zinc
Silver
Electrocolor
And Others



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The "LEAK-PROOF", "CORROSION-PROOF" and non-contaminating construction of Industrial Filters is a vital requisite of Electroplating filters.

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For testing—Electroplated or coated metals at 95 deg. Fah. in accordance with Army, Navy and Aeronautical specifications, as outlined in Bulletin AN-QQ-S-91-5 dated Dec. 1938. Also for controlled temperatures at any degree. Testing Cabinets lined throughout with rubber. Made in 4 sizes.

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In all metal cleaning processes SPEED is the big factor today. PERMAG Cleaners are fast and thorough; that is why hundreds of metal fabricating plants, turning out Defense products demand PERMAG Cleaning Compounds. PERMAG keeps cleaning costs low. For 20 years this Cleaner has given highest satisfaction to users. Write for more details and prices. If you have a cleaning problem, let us help you solve it.

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Practical Lessons in Arc Welding, By W. J. Chaffee. 100 pages. 77 illustrations. Paper cover. Published by Hobart Brothers Co., Troy, Ohio. Third edition in seventh printing. Price postpaid anywhere 50c. Special edition written in Spanish $2.

This concise arc welding book, written in easy-to-understand English, offers students, instructors, engineers, and executives an abundance of practical arc welding data and lessons. Patterned after the course of lessons offered in the Hobart Trade School, this book leads the student easily throughout all the fundamental stages of arc welding. Forty-two complete arc welding lessons are covered in the book.

Group of lessons include: Striking and manipulating the arc; welding with bare electrodes; welding and cutting with coated electrodes; welding light gauge steel. Each lesson gives complete instructions for practicing the exercise—material, position, proper electrode, current value, and polarity setting.

The author stresses practice as the means for acquiring welding proficiency—keeping technical material to a minimum.

Copies of the book may be obtained directly from the company or from anyone of its authorized distributors.

Associations and Societies

Engineering Defense Training Courses

New York University, New York, is conducting a series of training courses for engineering defense. Included in these courses is that entitled, "Protective Finishing of Engineering Products" EDT-18. This course is conducted twice a week for 7½ weeks or a total of 45 hours. In this course will be discussed types of finishing of engineering products for protection and decoration, organic, metallic and miscellaneous coatings, aircraft and structural finishing problems, and general engineering applications.

Applicants with an acceptable amount of industrial experience in the finishing or chemical field will be admitted.

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THE HARSHAW CHEMICAL CO.
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Anodes, Lead
Anodes, Nickel
Anodes, Silver
Anodes, Tin
Anodes, Zinc
Alum
Ammonium Muriate
Antimony Sulphide
Boric Acid
Cadmium Carbonate
Cadmium Chloride
Cadmium Hydrate
Cadmium Oxide
Caustic Soda
Cerium Carbonate
Cerium Oxide
Chromic Acid
Chromium Carbonate
Chromium Chloride
Chromium Fluoride
Chromium Hydrate
Chromium Sulphate
Cobalt Chloride
Copper Carbonate
Copper Chloride
Copper Cyanide
Copper Sulphate
Epsom Salts
Gold Chloride
Gold Cyanide
Gum Arabic
Hydrofluoric Acid
Hydrofluosilicic Acid
Iron Chromate
Lead Acetate
Lead Carbonate
Nickel Carbonate
Nickel Chloride
Nickel Fluoride
Nickel Ammonium Sulphate
Nickel Sulphate
Rosin
Sal Soda
Silver Chloride
Silver Cyanide
Silver Nitrate
Sodium Bicarbonate
Sodium Bisulphite
Sodium Cyanide
Sodium Fluoride
Sodium Gold Cyanide
Sodium Hyposulphite
Sodium Phosphate
Sodium Stannate
Sodium Sulphate
Stannous Sulphate
Sulphuric Acid
Tartaric Acid
Tin Chloride
Tin Bath Addition Agent
Zinc Carbonate
Zinc Chloride
Zinc Cyanide
Zinc Oxide
Zinc Sulphate

American Electroplaters' Society

New Haven Branch

Christmas Party

The 5th Annual Stag Dinner of the branch will be held Saturday, December 13, 1941 at Hejaz Grotto Club, corner Columbus and Howard Ave., New Haven, Conn. The affair will start at 6:30 P.M. with the dinner, and afterwards there will be formal entertainment and informal pleasure with the many facilities at the Grotto. All are welcome to attend and please make reservations with *Charles Koelbl*, 181 Main St., West Haven, Conn. Price of ticket, approximately $1.65.

Toronto and Buffalo Branches

Annual Meeting

A preliminary committee meeting was held at the Hotel Brock, Niagara Falls, Ontario, Saturday, November 15, to prepare for a joint educational session of the Toronto and Buffalo Branches of the A.E.S. *John Acheson* acted as chairman and a tentative date of Saturday, April 18th, 1942 was set, to be held at the Hotel Brock, Niagara Falls, Ontario, with the ladies attending. An invitation was extended to the Rochester Branch to join with us in this session.

The talks will deal with subjects of vital interest today, *Dr. C. J. Wernlund* of Niagara Falls is in charge of the educational program.

The program, advertising and tickets for the Canadian side of the border has *John Acheson* as chairman, and *Allan Byers, W. E. Price*, and *Arthur Severs* assisting, while on the American side of the border *W. M. Fotheringham*, chairman and *William Hart, Ray Kilroy* and *Dr. C. J. Wernlund* assisting.

A cordial invitation is extended to the A.E.S. members to join with us in an enjoyable and profitable meeting.

Los Angeles Branch

An address dealing wtih magnesium processing on defense contracts was delivered at the Los Angeles Branch meeting on November 12 by *James P. ApRoberts*, aircraft processing engineer of *Turco Products Co.*

The speaker presented a definition of magnesium, the various methods of process-

ing it and the equipment needed therefor, and an outline of cleaning, precleaning, electrocleaning and treatment of the metal.

The Program Committee, recently appointed to coordinate educational activities on a wider scale, rendered a report through Chairman *Emmette R. Holman.* The committee has reached the conclusion, Mr. Holman reported, that the branch's sessions should be featured by more papers prepared by members of the branch or representatives of their firms. The committee, he declared, is prepared to assist embryo speakers in the preparation of technical papers.

The Supreme Society's regulations for the preparation of papers for reading at national conventions and the rules on classification of papers were explanied by *Ernest Lamoureux.*

A motion picture, "The Hottest Flame in the World," presented through the courtesy of the General Electric Co., dealt with the treatment of tungsten under extremely high temperatures, depicting results of experiments with tungsten and nitrogen which have been made at the General Electric laboratories.

Personals

Frederick Fulforth with Sperry Gyroscope Company

Frederick Fulforth, well known in the plating industry and past president of the American Electroplaters' Society, became associated with the Sperry Gyroscope Co., Brooklyn, N. Y., November 1st. He was formerly finishing supervisor for Proctor Electric Co., Philadelphia, Pa. His home address, after December 1st. will be 112-15 72nd Rd., Forest Hills, L. I., N. Y.

The many friends of Fred wish him success on his new job.

Frederick Fulforth

Park Chemical Co., Detroit, Mich., announces the appointment of *Ambrose McNamara,* 215 Lansing Ave., Utica, N. Y., as sales representative for heat treating products, grain cements and polishing compounds for New York State. *H. W. Case,* 52 Willow St.. Springfield, Mass., will represent this company for sales in the New England territory.

The Keystone Carbon Co., St. Marys, Pa., manufacturers of commutator and slip ring brushes, porous bronze bearings, negative temperature coefficient resistors, and electrical contacts, announces the opening of an Eastern sales office at 249 High St., Newark, N. J. *Robert McKeown* and *Charles V. Allen* are district representatives, succeeding the late *E. A. Berger,* sales engineer. The Keystone Carbon Company also announces the appointment of *A. A. Barbera & Co.,* 417 South Hill St., Los Angeles, Calif., as representative for Keystone products in the Southern California territory.

The Quaker Chemical Products Corp. have announced the appointment of *Dr. Johan Bjorksten* as Director of their Laboratories.

Dr. Bjorksten was formerly Chief Chemist, in the order listed, of The Felton Company, The Pepsodent Company and Ditto, Inc. We believe his past training and positions will make him an invaluable adjunct in the handling of technical problems for Quaker's customers as well as in the development of new industrial chemicals for the industries that they serve.

Dr. Bjorksten is a graduate of the University of Helsingfors and also of the University of Stockholm where he worked under Dr. H. von Euler. He was later awarded a Fellowship by the Rockefeller Foundation and chose to work under Dr. R. A. Gortner at the University of Minnesota. He has passed the Patent Bar Examination in this country as well.

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✓ INCREASES PRODUCTION
✓ INSURES BETTER FINISH
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Polishing costs take a licking all along the line when this Acme 3-Wheel Automatic bites into a tough job of tube or pipe finishing. It gives a three-way savings by performing three operations in one pass through the machine. Adjustable feed speeds from 0 to 20 or more feet per minute and compensating adjustments for tube size and wheel wear meet every production and finish requirement.

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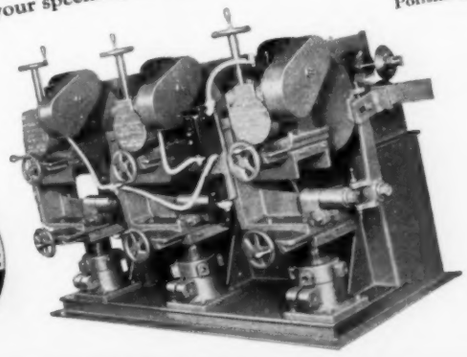
3-Wheel Automatic
Polishing Machine



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Builders OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR OVER 25 YEARS

D. Clark Matthews is the new Southern Ohio representative of *The Cowles Detergent Company*, Cleveland, Ohio. He is selling Cowles' complete line of alkaline metal cleaners. Mr. Matthews is an electrochemist and acquired his early experience in the field as an electroplater. More recently, he has become well known as a technical consultant on metal working and finishing processes. Matthews is married and has a daughter 11 months old. They live at 1231 East High Street, Springfield, Ohio.

D. Clark Matthews

Guard Against Waste Stickers

The Indium Corp. of America is distributing stickers with their watchword, "Waste is Sabotage," to be used in factories, plants, laboratories or wherever the slogan will be an effective reminder to guard against carelessness and prevent waste of vital materials. These stickers are printed in red and white and measure 4½" x 3¼".

Readers of Metal Finishing can secure copies by writing to the Indium Corp. of America at 60 E. 42nd St., New York City.

Business Items

Detroit Brass Foundry is completing a new warehouse at its Los Angeles plant, 5138 Alhambra Ave.

Littlefuse, Inc., of Chicago, has established a plant at 200 West Ong St., El Monte, Calif., and has started production of electrical aircraft fittings, such as fuses, fuse panels, terminals, control boards and circuit breakers. The new plant contains 24,000 square feet of floor area on a 2½ acre tract. Investment is approximately $100,000.

Joseph B. Kushner has moved his metal finishing and plating laboratory to larger quarters at 233 W. 26th Street, New York, from which quarters Mr. Kushner will continue his analysis, trouble shooting, installation and consultation service to the metal finishing industry.

Quaker Chemical Products Corp., Conshohocken, Pa., have broken ground on their property for a new two-story manufacturing plant totaling 40,000 sq. ft. This is in addition to the recent series of buildings which increased manufacturing and storage facilities by 16,000 sq. ft. All the new construction is of stone, concrete and brick. It is understood that orders have been placed for considerable new equipment for this new plant. The recently completed units are now functioning normally.

News from California

By Fred Herr

Contract for construction of a $3,000,000 magnesium oxide plant 33 miles northeast of Luning, Nev., has been awarded to *Macdonald Engineering Co.* of Chicago by Basic Magnesium, Inc., of Cleveland, O.

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Production Increased with
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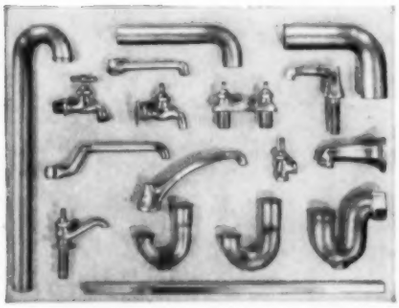
Today's Efficient Method of Volume Finishing



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HEADQUARTERS FOR

Sanding, rubbing and buffing compounds, tripoli, grease stick, rouge, white finish, emery cake and paste.

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MANUFACTURING COMPANY
DETROIT, MICHIGAN

The Southwestern Engineering Co. of Los Angeles will design the plant and type of equipment. Construction work began November 1. Upon completion of the plant, about June 1, 1942, 2,000 tons of magnesite will be treated daily.

Southwestern Engineering Co. will install equipment for a flotation mill, calcining unit and other departments for production of magnesium oxide, which will be shipped to the magnesium metal plant under construction at Las Vegas, Nev. Magnesium ore will be quarried from magnesite deposits in the Mammoth district of Nevada.

Erection of a concentration plant costing approximately $500,000 has been authorized by the *Rustless Steel Co.* of Baltimore, Md., at its Gray Eagle properties near Orland, Calif. The plant will have a capacity of 200 tons of chrome a day.

Recent rumors have been fairly well authenticated that the *Metals Reserve Co.* of the Reconstruction Finance Corp. will establish a manganese buying station and stamping mill in Phoenix, Ariz. It is reported that only ores of at least 40% manganese content will be accepted.

Richter Manufacturing Co., Burbank, Calif., has moved to larger quarters at 800 South Flower St., Burbank. Radio-controlled target planes and job machine work for the airplane industry are handled.

Wage increases ranging from 5% to 20% an hour, with a minimum scale of 55c, are provided in a no-strike, no-lockout contract signed by the *Cannon Electric Development Co.* of Los Angeles and the Cannon Employee's Association. The employee's association recently won the bargaining rights at the plant after a strike by C.I.O. electrical workers had precipitated violence at the gates. In an election supervised by the National Labor Relations Board, the C.I.O. was defeated.

Harvey Machine Co., 6200 Avalon Blvd., Los Angeles, has acquired a plant of 4½ acres floor area at 1401 West 17th St., Long Beach, Calif. After modernization has been completed (about January 1), the plant will be used in the manufacture of tools, dies and stampings.

The Osbrink Manufacturing Co. has construction underway on a 5,000 square foot addition to its aluminum foundry at 1412 East 62nd St., Los Angeles.

Phelps Dodge Copper Products Corp. of New York has acquired a 41-acre tract at Garfield Ave., near Whittier Blvd., East Los Angeles Calif., as a site for its projected $3,100,000 plant for manufacturing cupronickel, aluminum, brass and admiralty metal condenser tubes for the Navy and the Maritime Commission. Driving of piling for foundations to support specialized machinery and equipment began November 3.

Schigut Stamping Co., manufacturers of tools, dies, jigs and fixture stampings, has moved from 5772 W. Washington Blvd., Los Angeles, to a new plant with 30,000 square feet floor area and spur track facilities at 10,000 Exposition Blvd., Palms, Calif.

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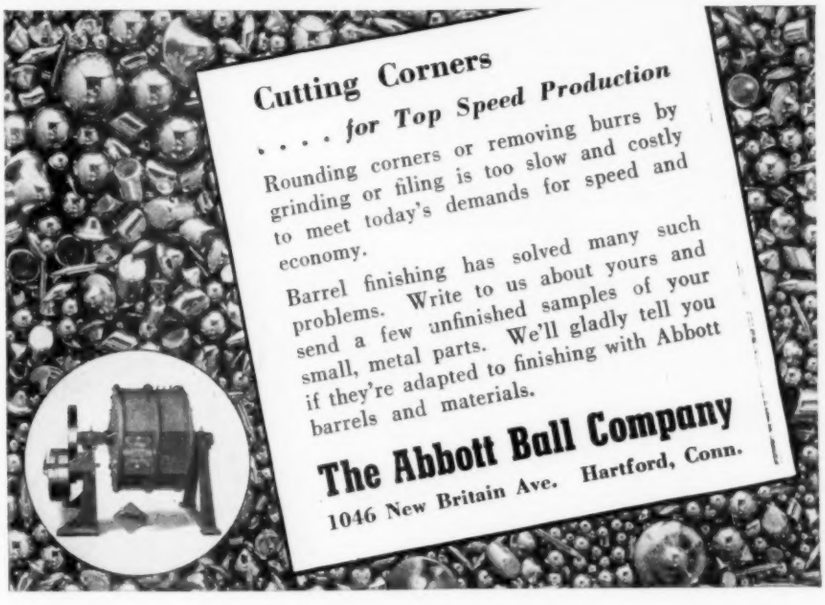
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Rounding corners or removing burrs by grinding or filing is too slow and costly to meet today's demands for speed and economy.
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To make an Ordinary Oxidizing Solution for Copper Plated Work:

Add one ounce McKeon's

"Liquid Sulphur"
TRADE MARK REG'D

to each gallon of water.

SULPHUR PRODUCTS CO., INC.
Greensburg, Pa.

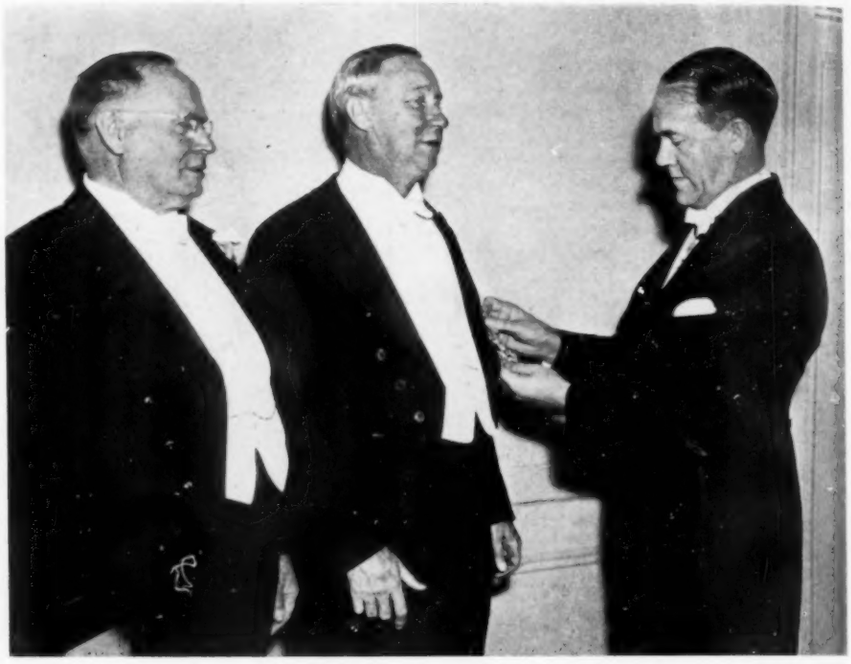
Let's go Grand Rapids AES Convention June '42.

Edward Magnuson Honored by Swedish King and 300 Friends

EDWARD MAGNUSON, president of the Magnuson Products Corp., Brooklyn, N. Y., was honored Oct. 25th by 300 persons for his activity in Swedish circles. The dinner was held at the Hotel Bossert, Brooklyn, and among those present were Borough President *Cashmore* and Supreme Court Justice *Francis D. McGarey*. Former Children's Court Justice, *Peter B. Hanson*, was toastmaster and *Henry Johnson* was chairman of the dinner committee. Mr. Magnuson is vice-president of the Swedish Hospital and received a scroll in testimony to his services.

On November 11th at an annual dinner of the Brooklyn Swedish Hospital, *Martin Kastengren*, Swedish Consul General in New York, conferred the decoration of Chevalier of the Order of Vasa, first class, on Mr. Magnuson on behalf of *King Gustav V* of Sweden. The presentation was made in recognition of the charitable endeavors of Mr. Magnuson in regard to the Swedish Hospital.

At testimonial dinner. Edward Magnuson (center), Brooklyn Borough President. Cashmore (left) and Peter B. Hanson (right).



Edward Magnuson (left) and Peter B. Hanson (center) being presented with the decoration, Chevalier of the Order of Vasa, from Martin Kastengren, Swedish Consul General, N. Y., acting in behalf of King Gustav V of Sweden.

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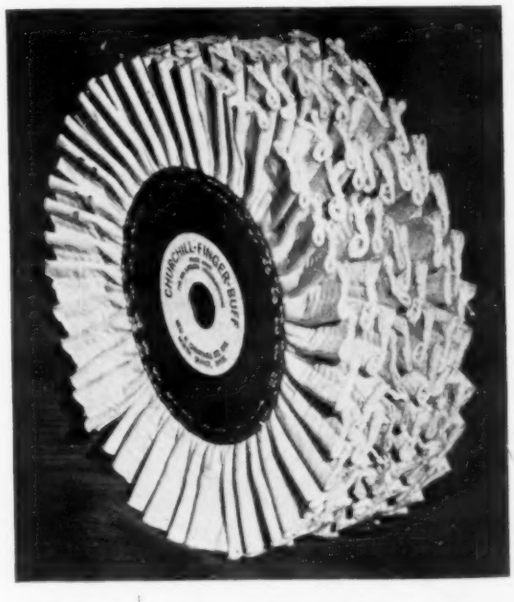

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FOLDED FINGER EDGE gives LONG WEAR
AVAILABLE in SOFT, MEDIUM and HARD grades
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Supply Prices, November 21, 1941

Anodes

Prices are f.o.b. shipping point on quantities of from 500-999 lbs. for copper, brass and zinc. For nickel, prices are for quantities from 500-2,999 lbs.

COPPER: Cast, elliptical, 15" and longer ..... 25¼c. per lb.
Electrolytic, full size, 22⅞c; cut to size 22⅞c. per lb.
Rolled, oval, straight 15" and longer 23¼c. per lb.; curved ..... 24¼c. per lb.

BRASS: Cast, 80-20, elliptical, 15" and longer .... 23⅝c. per lb.

ZINC: Cast, 99.99, 16" and over ..... 16¼c. per lb.

NICKEL: 95-97 cast, elliptical 46c. per lb., 99% plus cast 47c.; Rolled, depolarized ..... 48c. per lb.

SILVER: Rolled, .999 fine per Troy oz. ..... 38c. per oz.

Chemicals

These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P., drums, l.c.l.	lb.	.09
Acid, Boric tech., 99.5% gran., bbls.	lb.	.0615
Chromic, 99%, 100 lb. drums, l.c.l.	lb.	.18¼
Hydrochloric (muriatic) Tech., 20°, carboys, wks.	lb.	.0270
Hydrochloric, C.P., 20°, bottles	lb.	.19
Hydrofluoric, 30% bbls.	lb.	.06-.06½
Nitric, 36°, carboys 1-9, wks.	lb.	.0595
Nitric, 42°, carboys 1-9, wks.	lb.	.0745
Oleic (Red Oil), distilled, drums	lb.	.12-.13
Oxalic, bbls. l.c.l.	lb.	.14½
Stearic, distilled, double pressed, bags	lb.	.14¼-.15¼
single pressed, bags	lb.	.13¾-.14¾
triple pressed, bags	lb.	.17-.18
Sulphuric, 66°, carboys 1-9, wks.	lb.	.0245
Alcohol, Amyl, (Fusel oil, ref'd), l.c.l., drums	lb.	.17½-.19½
Butyl-normal, l.c.l., drums	lb.	.11½-.12¼
Denat., S.D. #1, 190 pf., 1-18 drms, wks.	gal.	.35½
Diacetone, tech., drums, l.c.l.	lb.	.11½-.12½
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.58½
Propyl-Iso, 99%, drums, l.c.l.	gal.	.43-.47
Propyl-Normal, drums, wks.	gal.	.67-.70
Alum, ammonia, granular, bbls., works	lb.	.04
Potash, granular, bbls., works	lb.	.0425
Ammonia, aqua, 26°, carboys	lb.	.05¼
Ammonium, chloride (sal-ammoniac), white, granular, bbls., wks.	lb.	.0675
Sulphocyanide (thiocyanate), pure, crystal, kegs	lb.	.55
Sulphocyanide (thiocyanate), tech., kegs	lb.	.40
Antimony Chloride (butter of antimony), sol., carboys	lb.	.17
Barium Carbonate, ppted., bags, l.c.l., works	lb.	.03
Benzene (Benzol), 90%, drums, works	gal.	.19
Butyl Lactate, drums	lb.	.235
Cadmium Oxide, l.c.l., bbls.	lb.	.95
Calcium Carbonate (Ppted. chalk), c.l., wks.	lb.	.02⅞
Carbon Bisulfide, l.c.l., 55 gal. drums	lb.	.05¾
Carbon Tetrachloride, l.c.l., drums	gal.	.80
Chromic Sulphate, scale, 100 lb. drums	lb.	.45
Cobalt Sulphate, drums	lb.	.71
Copper, Acetate (verdigris), bbls.	lb.	.26
Carbonate, 52-54%, bbls.	lb.	.16½
Cyanide, Tech., 100 lb. bbls.	lb.	.34
Sulphate, 99%, crystals, bbls., 1-5	lb.	.0535
Cream of Tartar (potassium bitartrate), gran., kegs	lb.	.58½
Crocus Martis (iron oxide) red, bbls.	lb.	.03¼
Dibutyl Phthalate, drums, l.c.l.	lb.	.195-.205
Diethylene Glycol, drums, l.c.l., works	lb.	.155
Dextrin, white, bags, F.O.B. Chicago	lb.	.0395
Emery (Turkish)	lb.	.08
Ethyl Acetate, 85%, l.c.l., drums, works	lb.	.09-.10
Ethylene Glycol, l.c.l., drums, works	lb.	.15½-.18½
Monoethyl ether, dms., l.c.l., wks.	lb.	.125-.155
Gold, Chloride, yellow, bottles	oz.	$19.25
Cyanide, potassium 41%, bottles, wks.	oz.	$14.20-$14.95
Gum, Arabic, white, powder, bbls.	lb.	.21½-.22
Hydrogen Peroxide, 100 volume, carboys	lb.	.16-.18¼
Iron Sulphate (Copperas), cryst., bbls., 1-4 wks.	lb.	.02
Lead, Acetate (Sugar of Lead), crystals, bbls.	lb.	.12½
Oxide (Litharge), com., powdered, bbls.	lb.	.08¼
Magnesium Sulphate (Epsom Salts), tech., bbls.	lb.	.018
Mercury Bichloride (Corrosive Sublimate), crys.	lb.	$2.39
Mercuric Oxide, tech., red, powder, bbls.	lb.	$3.11
Nickel, Carbonate, dry, bbls.	lb.	.36-.36½
Chloride, bbls.	lb.	.18-.20
Salts, single, 425 lb. bbls.	lb.	.135-.145
Salts, double, 425 lb. bbls.	lb.	.135-.145
Paraffin, refined, bgs., 123-125 a.m.p., c.l.	lb.	.06
Perchlorethylene, drums, l.c.l.	lb.	.08½
Phosphorus, red, cases	lb.	.44
yellow, cases	lb.	.23-.25
Potash, Caustic, 88-92%, flake, drums, works, c.l.,	lb.	.07
Potassium, Bichromate, crystals, casks	lb.	.10
Carbonate (potash) calc., wks. drums		.06¾
Cyanide, 94-96%, dom. dms., wks.	lb.	.55
Pumice, ground, 1½ F. & coarser, bbls., wks.	lb.	.04¼
Quicksilver (Mercury), dom. 76 lb. flasks, net	flask	$199.-$201.
Rochelle Salts, crystals, bbls.	lb.	.44
Rosin, gum, B, bbls., dock	lb.	.0327
Silver, Chloride, dry, 50 oz. lots	oz.	.37½
Cyanide, 100 oz. lots	oz.	.33¾
Nitrate, 100 oz. lots	oz.	.26⅞
Sodium, Carb. (soda ash), light, 58%, bags	lb.	.0213
Cyanide, 96%, dom. 100 lb. drums	lb.	.15
Hydroxide (caustic soda) 76%, flake, l.c.l.	lb.	.0490
Hyposulphite, crystals, bags, wks.	lb.	.0250
Metasilicate, granular, 1-9 bbls.	lb.	.0335
Nitrate, rfd., gran., bbls., wks.	lb.	.029
Phosphate, tribasic, tech., bbls., wks.	lb.	.038
Pyrophosphate, anhydrous, bags, l.c.l.	lb.	.0660
Sesquisilicate, 1-9 drums	lb.	.0430
Stannate, drums	lb.	.365
Sulphate, anhydrous, bbls., works	lb.	.0215
Sulphocyanide, drums	lb.	.55-.65
Sulphur, Flowers, U.S.P., bbls., l.c.l. mine	lb.	.039
Tin Chloride, crystals, kgs.	lb.	.39-.39½
Toluene (Toluol), 2°, ind., drums, works	gal.	.32
Trichlorethylene, drums, l.c.l., zone 1	lb.	.08½
Tripoli, air floated, bgs., c.l., wks.	ton	$26.00
Wax, Bees, white, bleached, slabs, 1-5 cases	lb.	.56
Bees, yellow, crude, Brazil, 100 lbs.	lb.	No stocks
Carnauba, refined, bags	lb.	.85
Montan, bags	lb.	.45-.46
Spermaceti, blocks	lb.	.24-.25
Whiting, precipitated, bags, l.c.l.	ton	$18.-$25.
Xylene (Xylol), ind., returnable drums, works	gal.	.31
Zinc, carbonate, tech., bbls.	lb.	.20
Cyanide, 100 lb. kegs	lb.	.33
Chloride, tech., granular, drums, c.l., wks.	lb.	.08
Sulphate, crystals, bbls., l.c.l.	lb.	.039

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